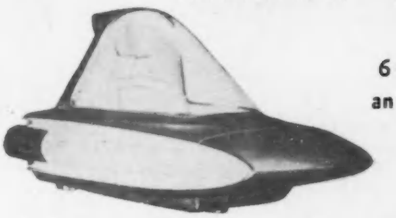
MARCH 1960



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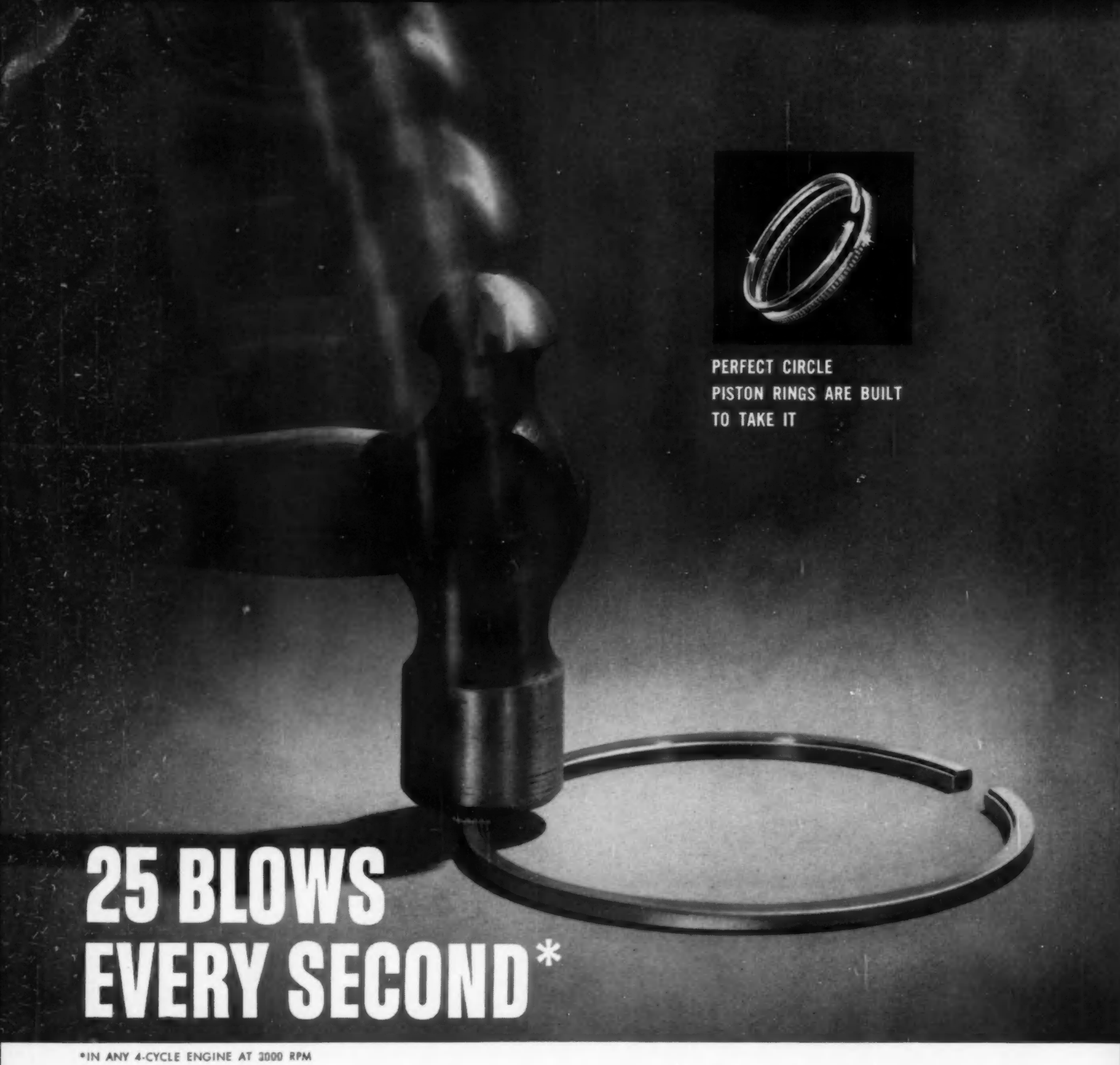
PUBLISHED BY THE SOCIETY OF AUTOMOTIVE ENGINEERS

JOURNAL



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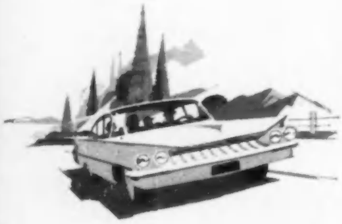

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A complete index of all Journal technical articles, from January through December, will appear in the December issue. All Journal technical articles are indexed by Engineering Index, Inc. SAE Journal is available on microfilm from University Microfilms, Ann Arbor, Mich.

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Briefs of SAE PAPERS

Presented here are brief digests of recently presented SAE papers. These papers are available in full in multilith form for one year after presentation. To order, circle the numbers in the "Readers Information Service" blank on page 6 corresponding to the numbers appearing after the titles of the digests of interest to you.

AIRCRAFT

Systems Approach to Support of Jet Aircraft, C. J. BREITWIESER. Paper No. 109V. Application of Systems Approach as it applies to support requirements for jet aircraft ranging from fighter to heavy transport or bomber; there are two primary operations which have to be accomplished, maintenance and ground movement; principles adopted by USAF and Navy with respect to these areas are outlined.

Convair 880 Fuel System Test Program, J. McCAFFERTY, G. KAREL. Paper No. 107V. Test program consists of small-scale model tests, full scale test stand, icing and low temperature test stand, fuel quantity gaging system calibration, and individual fuel system component tests; first three phases are discussed in detail; test results.

Effect of Innovation on Next Decade of Space Age, G. H. STONER. Paper No. S224. Problems to be solved in connection with indefinite duration of flight when required for continuous alert; plasma experiments which may lead to larger application of magnetohydrodynamics; advances in art of miniaturization of electronic equipment, necessary for space flight; research in field of micro-circuitry and molelectronic techniques which may further improve component space utilization.

FUELS & LUBRICANTS

Automatic Transmission Fluids Low Temperature Viscosity Studies, R. E. CROSTHWAIT, W. F. GREENAWALT. Paper No. 124U. Automatic transmission fluid low temperature Brookfield viscosities used to evaluate fluid performance under extreme cold conditions; laboratory use of technique has indicated that automatic transmission fluid low temperature viscosity behavior is best studied in fully formulated blends that contain all components of balanced fluid; lighter viscosity base oils offer best low temperature fluidity.

Study of Gear Lubricant Thermal-Oxidative Degradation Phenomena. N. T. MECKEL, R. D. QUILLIAN, Jr. Paper No. T38. Details of program conducted at Ordnance Fuels and Lubricants Research Laboratory: development of reliable test technique to evaluate thermal-oxidation stability of gear lubricants for MIL-L-002105A specification; investigation of thermal-oxidative degradation phenomena through isolation of oxygen and temperature effects; consolidated test results tabulated.

Automatic Transmission Fluid Viscosity at Low Temperature and its Effect on Transmission Performance, T. W. SELBY. Paper No. 124T. Low temperature study of relationship between performance of step-type automatic transmission and transmission fluid viscosity reported; it is shown that low temperature malfunction of these units is due to viscometric properties of fluid and that at temperature at which fluid reaches certain critical viscosity transmission will fail; mathematical analysis of mechanism of failure supports conclusions drawn from experimental study.

Oxidation Stability, Shear Stability and Rubber Swell Properties of Automatic Transmission Fluids, H. E. DEEN, C. M. STENDAHL. Paper No. 124V. New test described for studying oxidation stability of automatic transmission fluids (ATF); tests shows excellent correlation with transmission oxidation tests; test data on shear stability of ATF's show comparison of driving conditions, transmissions, and V.I. improvers on shear stability; poor reproducibility of rubber swell measurements on commercial transmission seals is due largely to differences in rubber compounds.

Motor Oil Evaluations in Low-Duty, High-Output Engines, O. L. SPILMAN, W. F. FORD. Paper No. 126T. Consideration of used oil condition as measured by routine type analytical methods; results have provided certain relationships or correlation between

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SAE JOURNAL, March, 1960, Vol. 68, No. 3. Published monthly except two issues in January by the Society of Automotive Engineers, Inc. Publication office at 10 McGovern Ave., Lancaster, Pa. Editorial and advertising department at the headquarters of the Society, 485 Lexington Ave., New York 17, N. Y. $1 per number; $12 per year; foreign $14 per year; to members 50¢ per number, $5 per year. Entered as second class matter, Sept. 15, 1948, at the Post Office at Lancaster, Pa., under the Act of Aug. 24, 1912. Acceptance for mailing at special rate of postage provided for in the Act of Feb. 28, 1925, embodied in paragraph (d-2), Sec. 34.40, P. L. and R., of 1918. Additional entry at New York, N. Y. Second class postage paid at Lancaster, Pa. and additional office N. Y. C.

Briefs of SAE PAPERS

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used oil condition and performance, and indications of how and why deposits were formed in addition to usual measure of how much; they have also furnished guidance for improved test control; relationships may be adapted to any engine test technique; results to-date are sufficient to illustrate potential of these correlations.

One Test Evaluates Motor Oil Contribution to Combustion Deposits, L. D. LaCROIX, M. L. KALINOWSKI. Paper No. 126U. In laboratory procedure developed by Standard Oil Co. (Indiana) with production model V-8 engine, single deposit accumulation cycle shows effects of motor oil composition on octane requirement increase, surface ignition, rumble, and spark plug fouling; tests on seven commercial 10W-30 oils show that octane requirement increase is affected more by motor oil differences as compression ratios rise.

Multigraded Dispersant Detergent Oils — Best Way to Keep Engines Clean, A. E. BRENNEMAN, E. D. NOSTRAND. Paper No. 126V. Series of three taxicab field tests ranging between 18,000 and 25,000 mi conducted; V.I. improver/dispersants as class used in combination with detergent inhibitors impart notable improvement to performance of 10W-30 grade motor oils in controlling engine cleanliness; new type V.I. improver/dispersant based on new polymeric backbone and polar component is very effective in minimizing engine deposits.

Seasonal Octane Control, F. J. SANDERS, E. H. SCOTT. Paper No. 127T. Results of studies by Standard Oil Co., (Ohio) in relating Ohio weather conditions to engine octane requirements, and application to customer requirements; studies showed that engine requirements increase in spring and fall and decrease in summer and winter; fuel octane numbers could be adjusted seasonally and to better satisfy customer requirements.

Tertiary-Butyl Acetate — Octane Improver for Leaded Gasolines, S. R. NEWMAN, K. L. DILLE, R. Y. HEISLER, M. E. FONTAINE. Paper No. 127U. Factors found to affect octane response of TLA (Texaco Lead Appreciator) in high octane, commercial type fuels and octane response of various fuels to TLA; storage stability, handling and usage of gasolines containing TLA and their performance in automotive equipment described.

Induction Systems Affect Fuel Antiknock Behavior, A. W. PERCY. Paper No. 127V. Three 1957 vehicles selected for fuel rating program in order to study effect of changes in fuel sensitivity and olefin content on Road octane performance; three sets of fuels were blended at nominal 94, 98, and 102 Research octane numbers; test data illustrated and analyzed.

Part-Throttle Knock, H. A. TOULMIN, D. L. LENANE. Paper No. 128T. Results of investigation of some of fundamentals of part throttle knock and effects of fuel antiknock quality and design on this problem; road antiknock performance data obtained on 30 premium fuels in five 1959 passenger cars, and additional data in six cars on two special sets of fuels, one with constant Research and one with constant Motor octane number; most important fuel factor in controlling part throttle knock is Motor octane number.

Part-throttle Economy and Octane Quality Demand of Current V-8 Engines, J. H. FREEMAN, Jr., W. A. FORREST. Paper No. 128U. Two automotive engines run on dynamometer test stands; operational areas considered include road load, part throttle and full load; data indicate that increases in road load fuel economy in order of 10% are possible with such engines, but that under these conditions they become knock limited on commercial type gasolines at part throttle, rather than full load; with fuels of zero sensitivity, full throttle results continue to predict maximum octane requirement.

Road Rating of Fuels at Part Throttle, J. C. ELLIS, W. F. FORD, E. H. SCOTT, G. W. STANKE. Paper No. 128V. Description of program designed to obtain triplicate vehicle ratings of six test fuels in six makes of 1958 cars; fuels were rated by Modified Uniontown and Modified Borderline techniques up to 4000 rpm; each fuel was rated at maximum throttle opening and at part throttle opening corresponding to manifold vacuum of 12 in. of mercury; analysis of data obtained.

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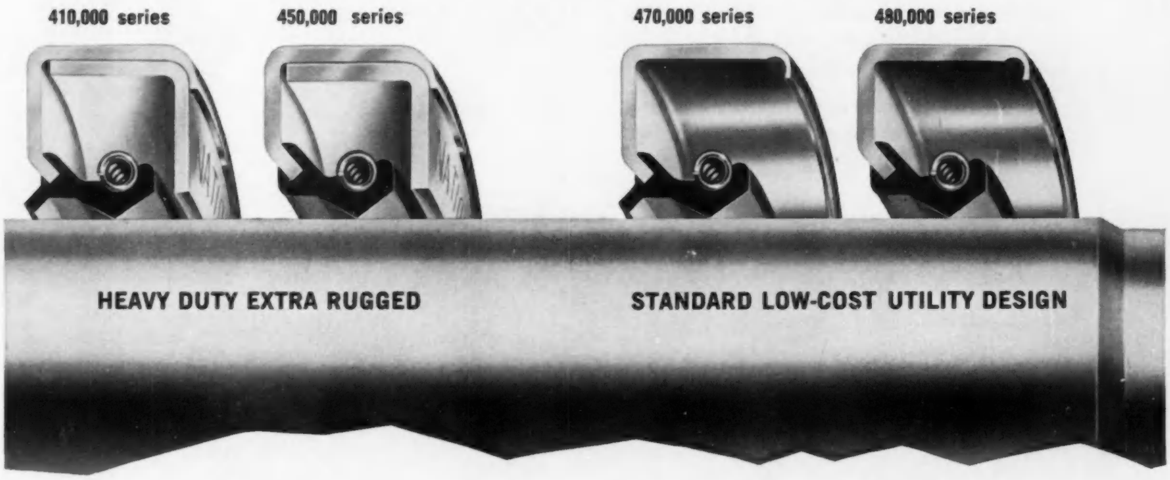

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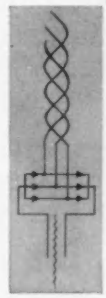

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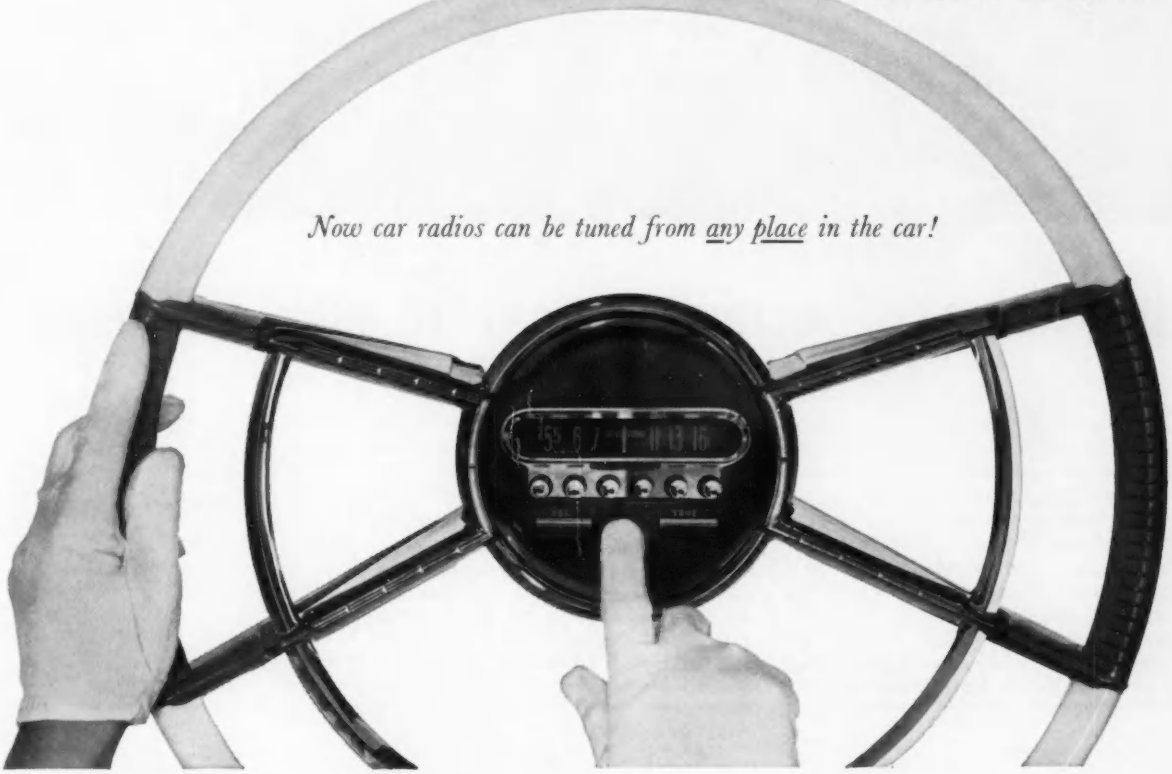

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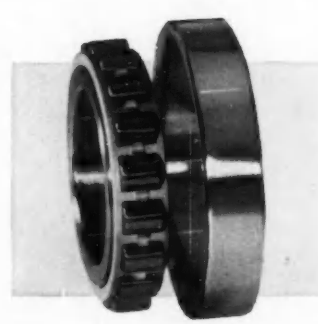

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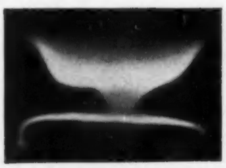
To do this, the almost invisible cool flames are stabilized for hours in a flat-flame burner, permitting careful examination of the retardation or acceleration effects of the additives. From more than twenty additives studied, experimental results indicate that some chemicals affect combustion through the mechanism of preflame reactions. We are now accumulating new information on these additives' mode of operation. For instance: emission spectra support the conclusion that tetraethyl lead reacts with the oxygenated compounds formed in cool flames to yield lead oxide vapor. These findings of when and how lead oxide is formed are important in resolving a current controversy of science — the combustion behavior of tetraethyl lead.

Studies such as this may lead to more economical and effective means of controlling unrestrained combustion — such as "knock" in reciprocating engines. The work is typical of GM Research's effort to provide useful information for a moving America. And in this way continue to keep our promise of "More and better things for more people."

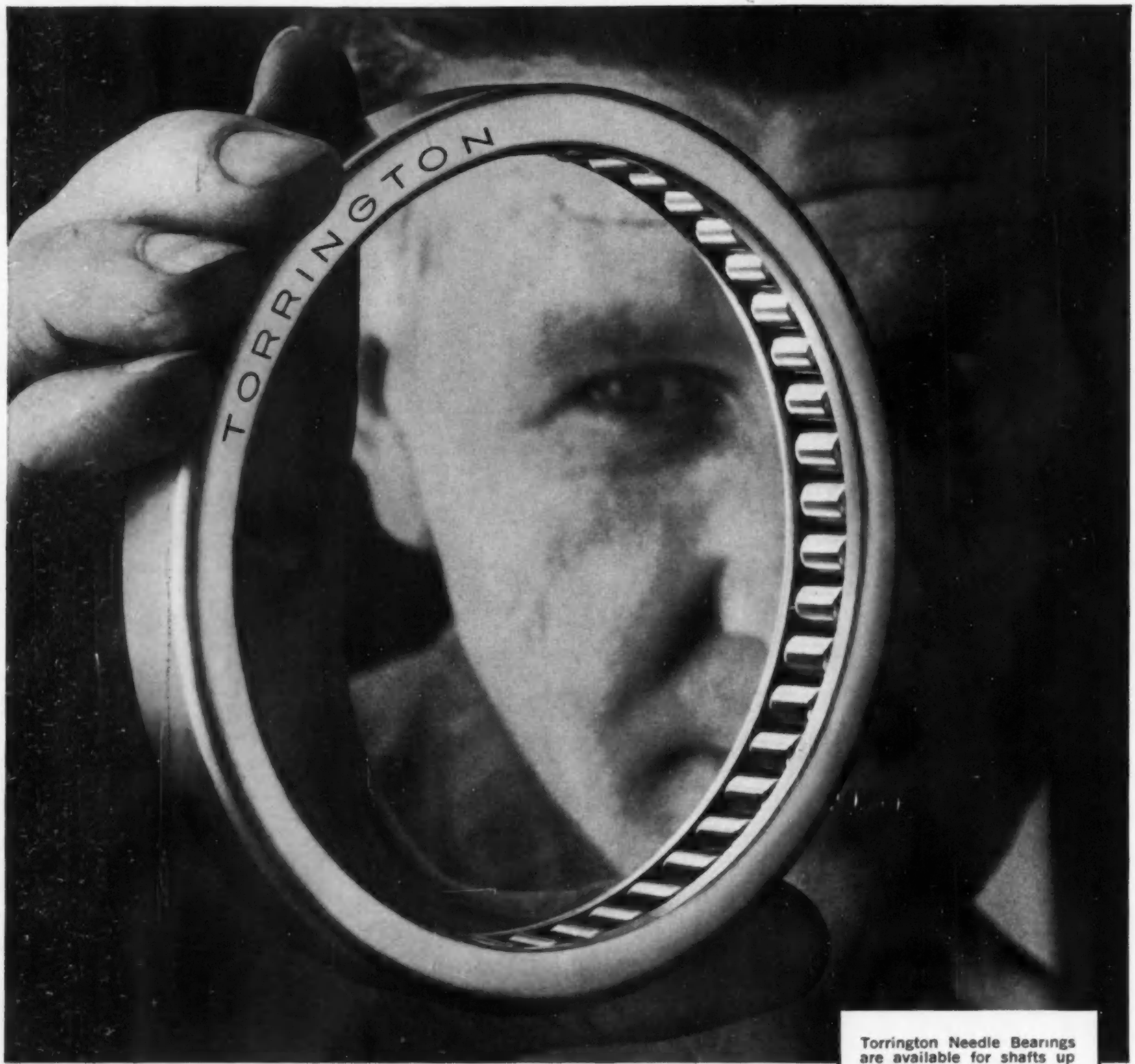
General Motors Research Laboratories
Warren, Michigan

Iron carbonyl, an antiknock



Ethyl nitrate, a proknock

Iron carbonyl retards, ethyl nitrate accelerates central portion of cool flames.



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SAE JOURNAL

For Sake of Argument

"Makes and Breaks" in Success . . .

EVERY ENGINEERING SUPERVISOR has seen one of two men with equal education and experience become successful while the other has failed . . . or just plodded along.

What makes the difference? Probably the "intangibles." . . . Intangible personal qualities often make or break a man on a particular job. Man and job must be matched as to personal strengths as well as to experience.

Most engineer-employers can list the qualities most needed for success on each of the jobs they supervise. They pretty well know how much things like accuracy, reliability, intellectual honesty, creativity, quickness in learning, and so on are *required* for this job. They also know, of course, the degree of knowledge and experience *necessary*.

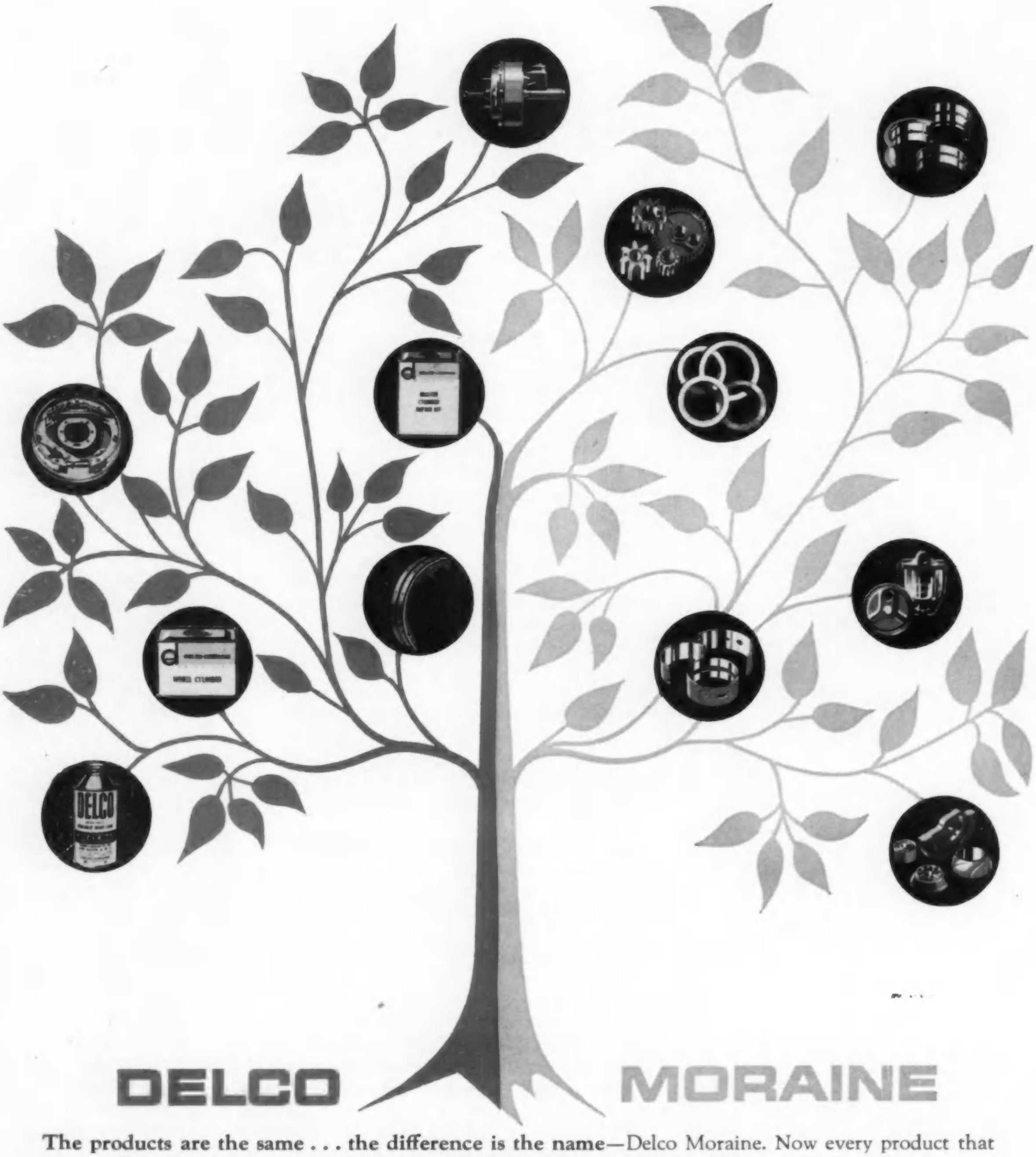
But no longer are astute employers either hiring or promoting on the basis of experience alone. More and more they try for advance knowledge of how the candidate will affect the efforts of those he works with; whether he tends to meet a business challenge, dodge it, or be confused by it; whether he usually sees the fallible features or the positive potentials of a new situation.

Only way to get advance information on such qualities, New York's Man Marketing Clinic says, is to dig into the candidate's past. Ask him to tell you of some specific problems he has met, what he did about them . . . and what resulted. Then make up your own mind as to what qualities are revealed by those instances. The man is very likely to apply the same sort of mental processes to future problems as to past ones, Clinic experience indicates.

So, suggests the Clinic, put the particular man on a job which *requires* a considerable exercise of those qualities in which he is strongest. (We're all stronger in some respects than in others.)

The result is likely to be a definite increase in the percentage of really successful engineers.

Norman G. Shidle



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SPARK BOMB device has been developed by Republic Aviation for forming metals which are extremely difficult to work. Electrical power is stored by capacitors and released in 40 millionths of a second. The discharge takes place under water and develops a high-velocity shock wave, which is directed toward the material to be worked. Several thousand horsepower have been developed in this almost direct conversion of electrical energy to mechanical power.

SPECIFICATIONS FOR NEEDED PRODUCTION FACILITIES, says Convair's H. A. Smith, should be so written as to communicate information clearly, concisely, and objectively. "All too often," Smith warns, "specifications become a monument to their writer . . . commemorating in burdensome detail both his command of the subject and of the English language. Avoid lengthy, involved, and obscure specifications!"

SIMULATING OUTER SPACE VACUUM is difficult down here on earth. At present, oil diffusion pumps are used to generate vacuums down to 10^{-8}mm Hg. This corresponds to an altitude of 250 miles. Ion pumps extend this vacuum down to 10^{-10}mm Hg, which still takes us only 550 miles into space.

The difficulty in producing these vacuums is complicated by gases generated by the materials or systems under test. An ion propulsion system must be tested in low vacuums and the ions generated must be removed to maintain the vacuum. Under normal atmospheric conditions, metals are protected by an oxide film. This film in turn is covered by an adsorbed layer of gas or water vapor. When this surface is in a high vacuum environment, the adsorbed surface gas is decreased and the coefficient of friction can increase by as much as a factor of 2. With addition of heat, the coefficient of friction will increase even more, to the point where it may rise to a value of more than 100 times normal when metal and oxide evaporation occur.

Graphite, under atmospheric conditions, is a good lubricant, but under high vacuum conditions it becomes abrasive. Rotating or sliding parts on the outside of the pressurized vehicle must be reduced to a minimum to avoid potential trouble spots.

LATEST IN MATERIALS HANDLING — There are plans to move fruits and vegetables through pipelines from the source to the city produce markets. The produce would be conveyed through the pipes by water pressure. The consumer would receive clean and fresher produce.

OVER 60 TIMES AS MANY ENGINE FAILURES occur en route as occur on take-off, according to G. E. Rice of Aerojet-General Corp.

A MACHINE TO PLAY CHECKERS is among those utilizing advances in magnetic information storage elements which accept quantities of factual information and react according to prescribed laws of logic to provide logical answers to new problems fed them. This checker-playing machine stores its experience in each game and refines its techniques so that it becomes more and more difficult to defeat.

BALANCING TRUCK FRONT TIRES does raise the comfort level for drivers, but there is little economic justification for balancing to improve tire mileage. This is one company's conclusion after running tire test fleets and analyzing truck operator's experience.

"**IT IS BETTER TO DESIGN A SYSTEM THAT ACCOMPLISHES A FUNCTION DIRECTLY** rather than through three or four links in a chain," says Jack Dyment, Chief Engineer of Trans-Canada Air Lines. "On one modern transport purchased by several airlines, one operator, by specifying a rearrangement of the cockpit, was able to omit sixty items comprising indicators, warning lights, switches and controls that other airlines retained. The revised four-engine airplanes can be completely flown from either the pilot's or co-pilot's seat and the airline feels that the plane's overall reliability is greater without the sixty extra gadgets and additional man."

6 Ways Air

All ground effect machines (GEMs) work

With any design, the vehicle must be large to operate

SIX DESIGNS form the backbone of recently developed vehicles that move by sliding on a cushion of air. Each vehicle uses one or a combination of these six techniques to keep the air under it at a slightly positive pressure. Three of the techniques aim to produce an air seal at the edge of the vehicle, two allow a limited leakage, and one uses the forward motion of the vehicle to ram air under it.

Peripheral Seal

One of the three sealing-type vehicles does not recirculate the air under it (annular jet, see Fig. 1) while the other two do (labyrinth seal, see Fig. 2; diffuser, see Fig. 3).

The annular jet works by using the centrifugal force necessary to turn the jet of air coming out around the edge of the vehicle. This force is balanced by a pressure drop at the edge, which traps high-pressure air under the vehicle. The vehicle then floats on this high-pressure cushion. Most designs use inwardly inclined peripheral jets since this produces a sharper bend in the jet of air. This decrease in radius of curvature increases the centrifugal force and the pressure drop. Thus, the inwardly inclined jet supports a heavier vehicle, other things being equal.

The performance of an annular jet ground effect machine (GEM) is heavily dependent on its size to height-above-ground ratio. This is true for any of the six basic designs. The reason for this is that the power it takes to operate a GEM is a function of the height-above-ground and the perimeter, while the load-carrying capacity depends on the planform area of the vehicle. This is shown graphically in Fig. 4 where several curves for different size-height (S/hC) ratios[1] are plotted.

Practically speaking, there is a limit to the weight that can be supported by an annular jet or similar type of GEM for a given size of powerplant. Either the size gets too large or the ground clearance gets too small if a GEM is overloaded. Of the two factors, the height-above-ground is the most critical since small ground irregularities or waves must not obstruct the vehicle. This means that GEMs must be large to take advantage of their inherently high hovering efficiency if they are to operate over natural terrain. Fig. 5 shows that the GEM begins to compete with regular aircraft when S/hC passes 15. This is for a total coefficient of lift (C_L) of 2 and typical overall efficiency for cruise (η_{aoc}) of 0.45. Using a constant C_L value in this graph is the same as keeping the forward velocity and weight per square foot constant.

Recirculating Seal GEMs

The labyrinth seal type of GEM (Fig. 2) holds pressure under the vehicle by creating a viscous flow around the perimeter. The pressure seal is formed by the turbulence and dissipative mixing which take place in the narrow passage between the base of the machine and the ground. This mixing and turbulence is obtained when oblique jets recirculate air at the edge of the vehicle in such a direction as to oppose the flow of air away from the center of the

[1] Where S = planform area; h = ground clearance; and C = perimeter of S.

to Lift an Cushion Vehicle

on one or a combination of six basic techniques.

efficiently over natural terrain.

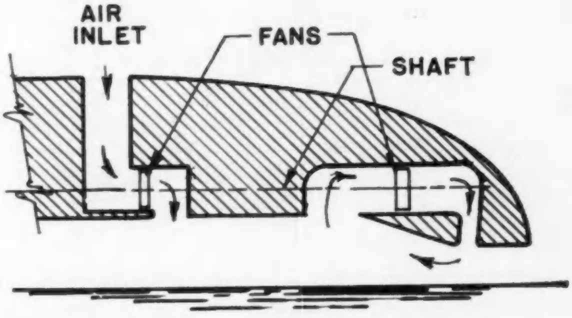


Fig. 2 — Labyrinth design uses viscous flow of air to seal pressure under vehicle.

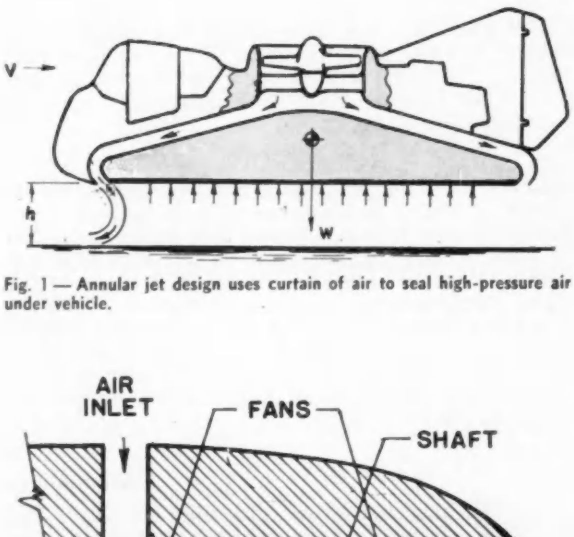


Fig. 1 — Annular jet design uses curtain of air to seal high-pressure air under vehicle.

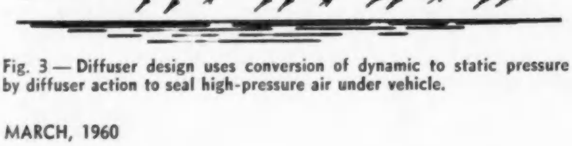


Fig. 3 — Diffuser design uses conversion of dynamic to static pressure by diffuser action to seal high-pressure air under vehicle.

The material for this article was drawn from the following papers:

Basic Principles of Ground Cushion Devices, by **Dr. Gabriel D. Boehler,** Aerophysics Co. and Catholic University of America (Paper No. 133A)

Sliding on Air, by **Alex L. Haynes and David J. Jay,** Ford Motor Co. (Paper No. 133B)

The Case for an Ocean-Going Ground Effect Machine, by **Harvey R. Chaplin,** David W. Taylor Model Basin (Paper No. 133D)

To Order Papers Nos. 133A, B, D
. . . on which this article is based, see p. 6.

6 Ways to Lift an Air Cushion Vehicle

. . . continued

GEM. Since each recirculating jet produces only a small pressure drop, this seal requires several stages, or a labyrinth. Early tests show that, aerodynamically, this is an efficient system, mainly because it uses a series of small pressure drops rather than a single large one. However, any analytical analysis is practically impossible because of the complexity of the design and the complications of analyzing a viscous flow.

The diffuser seal (Fig. 3) operates by converting high-speed air into low-speed, high-pressure air. It does this by diffuser action, similar to the diffuser of a wind tunnel. By building a "wind tunnel" around the edge of the GEM with the diffuser part pointing inward, a pressure seal is achieved. Two advantages of this design are the ease of calculating performance and the accomplishment of the pressure seal in one stage.

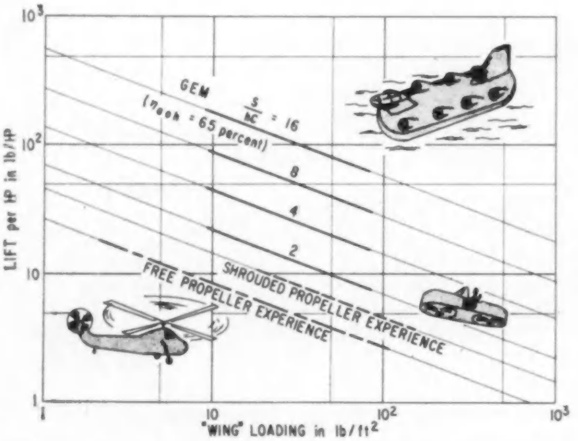


Fig. 4 — High ratio of planform size to air leakage area gives ground effect machine (GEM) a decided advantage in load-carrying ability per horsepower. While GEM can operate at a ratio of 16, theoretical limit for shrouded propellers is 2.

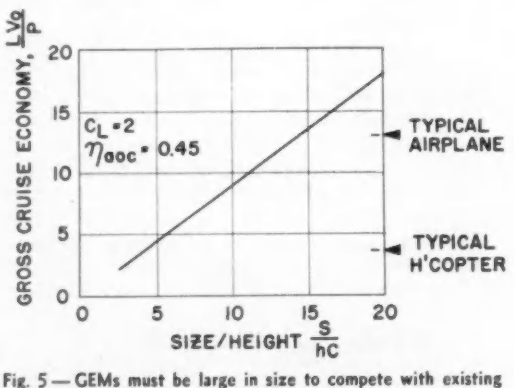


Fig. 5 — GEMs must be large in size to compete with existing aircraft. Rough terrain or waves force this large size by restricting how close vehicle can approach ground.

Air Leakage GEMs

The two types of air leakage GEMs are the plenum chamber (Fig. 6) and the levapad (Fig. 7). The plenum chamber acts like an inverted bath tub with air pumped in at the top. Pressure is maintained under the vehicle because of the pressure drop around the edge. This pressure drop results from the "restricted orifice" effect that comes from having the edge of the vehicle near the ground.

The critical part of this design is the shape of the plenum chamber. It cannot be assumed that the pressure in the main part of the chamber is constant because there is a slow-speed flow of air in the chamber that can separate from the walls by viscous action. When such separation takes place, the performance can be seriously affected.

The Levapad

This GEM is in a class by itself — it's the one case where the size of the vehicle *does not* have a direct effect on the cushion of air on which it slides. The air still leaks out through some form of orifice to create a pressure drop, but the height above "ground" is so small (around 0.010 in.), that a vehicle can be supported by a small pad. The main characteristic of the orifice is that turbulent flow exists between the pad and the ground. The very small clearance requires that a special "ground" be used. The typical case might be a steel rail. Examples of different types of orifices and a rail installation are shown in Fig. 7.

The load-carrying capacity of the levapad can readily be calculated assuming a viscous flow pattern. In fact the load capacity on a circular pad with an orifice extending from radius r_i to r_o and a supply pressure of p_i is:

$$\pi p_i (r_o r_i - r_i^2)$$

Also, the potential application of this GEM is vastly different. Since it must run on a smooth surface, it would travel on rails similar to railroads. However, unlike railroads, speeds up to 500 mph are possible because of the extremely low friction of the pads. Since a small pad carried the load, there is great flexibility to the size and shape of the vehicle. Lastly, the stability and control problems are much easier since the pad can be "locked" to a track and mechanical brakes can be used in addition to aerodynamic ones.

Ram Wings

The last basic design is a ram wing GEM (see Fig. 8). This wing operates close to the ground, at a few per cent of its chord. The lift comes from the quasi-static air cushion entrapped between the wing and the ground, rather than a downward change of momentum of the air stream, as in the case of regular wings. As a result, the stagnation point is at the trailing edge and the induced drag is zero. The lack of induced drag is the primary advantage of the ram wing over a conventional airfoil.

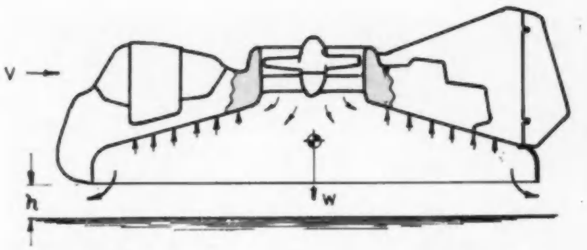


Fig. 6 — Plenum chamber design uses pressure drop across orifice at its edge to maintain high air pressure under vehicle.

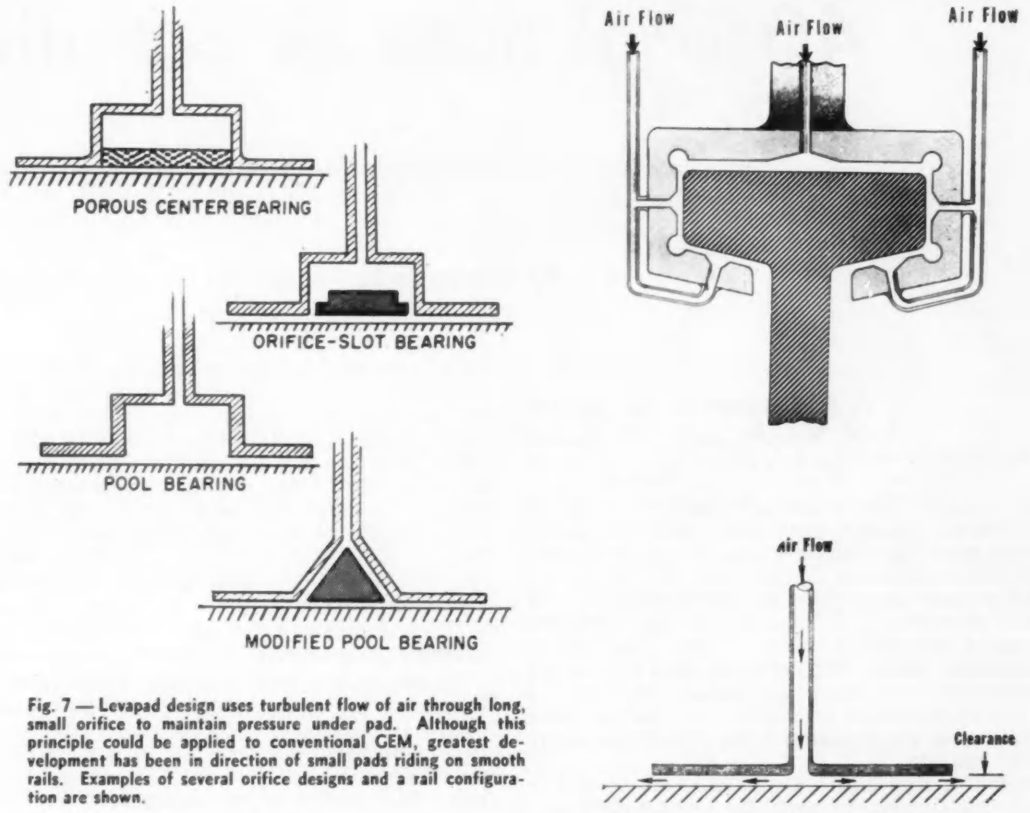


Fig. 7 — Levapad design uses turbulent flow of air through long, small orifice to maintain pressure under pad. Although this principle could be applied to conventional GEM, greatest development has been in direction of small pads riding on smooth rails. Examples of several orifice designs and a rail configuration are shown.

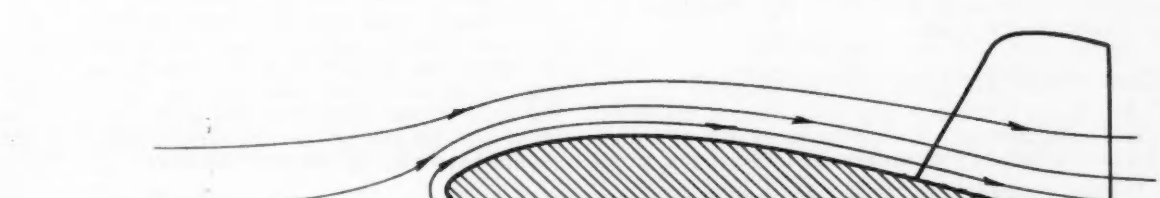


Fig. 8 — Ram wing design conveys dynamic pressure resulting from forward motion to static pressure under wing to support vehicle.

Crankcase gas causes 40%* of auto air pollution

–So, a major portion of auto hydrocarbon emission can be eliminated by internal crankcase ventilation.

Based on paper by

P. A. Bennett, M. W. Jackson, C. K. Murphy, and R. A. Randall

Research Laboratories, General Motors Corp.

CRANKCASE GAS is a major contributor to air pollution. In fact, tests show that hydrocarbon emission from the crankcase is of the same order of magnitude as that due to exhaust.

Blowby gases were shown to be predominately carbureted mixture. . . . This led to the conclusion (supported by further analyses) that the specific hydrocarbons in the fuel determine the specific hydrocarbons in the crankcase gases. Therefore, in cars whose crankcase emissions are not controlled, the fuel used will determine the crankcase hydrocarbons emitted.

Feeding engine crankcase gases back to the intake system eliminates crankcase hydrocarbon emissions without appreciably affecting exhaust emissions. An internal crankcase ventilating system can thus eliminate approximately 40% of the engine hydrocarbon emissions (considering crankcase plus exhaust, under all operating conditions) exclusive of carburetor vent losses.

Conventional crankcase ventilation system

Fig. 1 is a schematic of a conventional crankcase ventilation system. Blowby gases consist of a mixture of unburned fuel-air charge and exhaust products blown by the piston rings. Crankcase gases are composed of blowby gases and ventilation air. During normal car operation, ventilation air drawn in through the breather is mixed with the blowby gases, and the resulting mixture flows out through the road draft tube. When the breather and dipstick are plugged, the gases coming out of the draft tube are considered to be blowby gases. This definition ignores the absorption of blowby constituents by the lubricants, or any inclusion of entrained or vaporized lubricants.

Blowby composition

Blowby composition is an important factor in determining the extent of the problem of automotive crankcase emission. Typical Orsat analyses of exhaust and blowby gases are shown in Table 1. For both the rich and lean air-fuel ratios, the blowby gases had relatively low concentrations of carbon dioxide and carbon monoxide, and high oxygen concentrations. Because the crankcase was pressurized to avoid air dilution of the sample, the high oxygen concentration could not have resulted from air leakage. Therefore, the oxygen must have entered the crankcase in the gases blown by the piston rings. Because exhaust gases contain low concentrations of oxygen, the oxygen present in blowby gases must come from the carbureted mixture. Furthermore, the high oxygen concentration indicates that the blowby is predominately carbureted mixture and should have high hydrocarbon content.

***Exclusive of carburetor vent losses.**

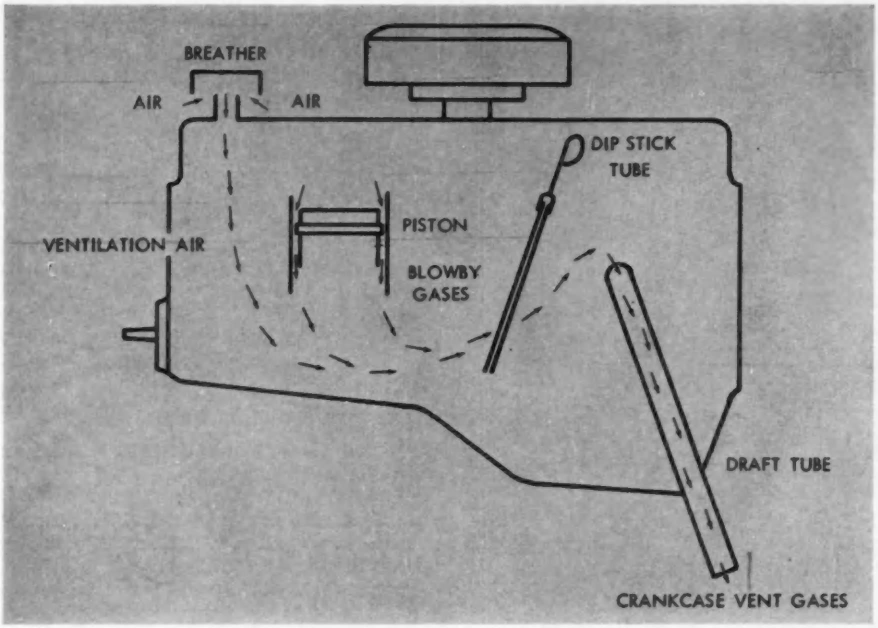


Fig. 1 — Conventional crankcase ventilation system.

To determine the amount of hydrocarbons present in the blowby gases, these gases were burned in a combustion-train using a Hopcalite catalyst. Samples collected before and after the combustion-train were analyzed by Orsat. Table 2 shows that oxidation of blowby gases resulted in a large increase in the carbon dioxide concentration. Oxygen concentration decreased markedly. These results show that there were large amounts of combustible material in the blowby gases. When exhaust gases were oxidized by a similar technique, the results indicated that combustible concentration was small.

In order to identify the blowby combustibles, grab samples were collected and analyzed by gas chromatography. Typical results are given in Figs. 2, 3, 4, and 5. These chromatograms indicate that blowby hydrocarbons are predominately fuel. Note the similarity between the fuel and blowby chromatograms from the phthalate, silicone and aroclor columns. Only the silica gel-alumina column shows pronounced differences between the fuel and blowby chromatograms. The small methane, ethane, and ethylene peaks of the blowby chromatogram are completely absent in the fuel analysis. The presence of these cracked products is attributed to the exhaust gases present in the blowby gases.

It is estimated from the Orsat analyses that blowby is approximately 85% carbureted mixture, and the remaining 15% is exhaust products. By assuming that carbureted mixture has a hydrocarbon concentration of 20,000 ppm C_6[1] and that exhaust

[1] The sum of individual hydrocarbon concentrations times the average carbon number of hydrocarbon mixture divided by 6 is equal to the concentration at ppm C_6.

Table 1 — Orsat Analyses of Exhaust and Blowby Gases (Engine of Make Z — Dynamometer Tests)

	Volume, %		
	CO_2	O_2	CO
Rich Air/Fuel (12.6)			
Exhaust Gas	11.0	0.7	4.6
Blowby Gas	1.5	17.9	0.4
Lean Air/Fuel (16.4)			
Exhaust Gas	13.0	2.6	0.5
Blowby Gas	1.8	18.4	0.3

Table 2 — Effect of Oxidation on Orsat Analyses of Exhaust and Blowby Gases (Engine of Make Z — Dynamometer Tests)

	Normal			Oxidized		
	CO_2	O_2	CO	CO_2	O_2	CO
Lean Air/Fuel (16.4)						
Exhaust Gas	13.0	2.6	0.5	13.5	2.1	0.0
Blowby Gas	1.8	18.4	0.3	11.9	4.0	0.0

has a concentration of 400 ppm C_6, estimates show that less than 1% of the hydrocarbon present in blowby gases would be from the exhaust fraction. . . . Over 99% would be directly from the carbureted fuel. Accordingly, specific hydrocarbons in the fuel will determine the specific hydrocarbons in the crankcase vent gases — a conclusion supported by the chromatographic analyses.

Crankcase emission levels

The levels of crankcase hydrocarbon emission from five cars on the road were reported. (See box on pp. 34–35 for individual results on each car, with sample calculations and assumptions needed to arrive at emission rates.)

Fig. 6 is a summary of crankcase emission rates for these cars at road load, expressed as a percentage of exhaust emission rates. (A value of 100%

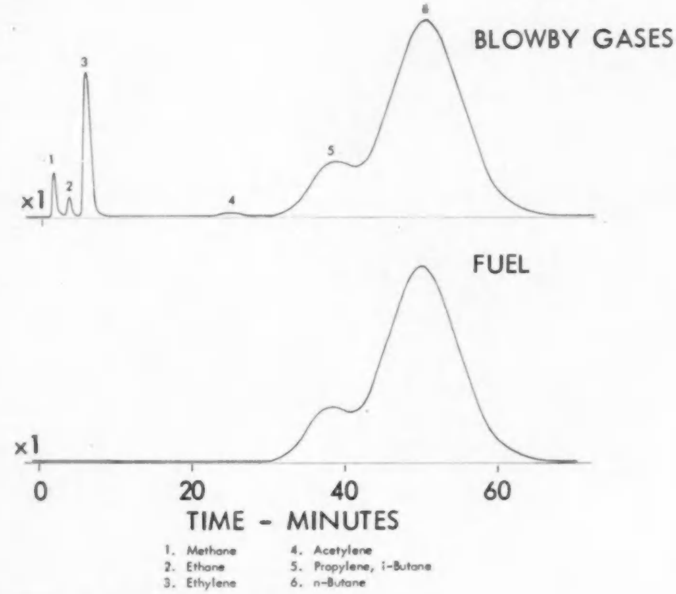


Fig. 2 — Silica gel-alumina column chromatograms.

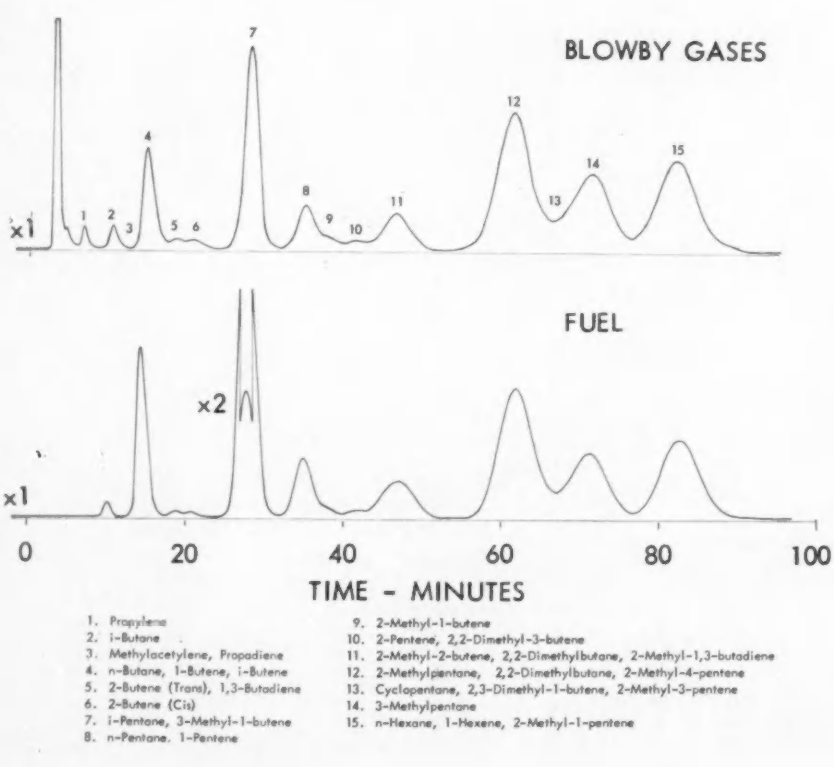
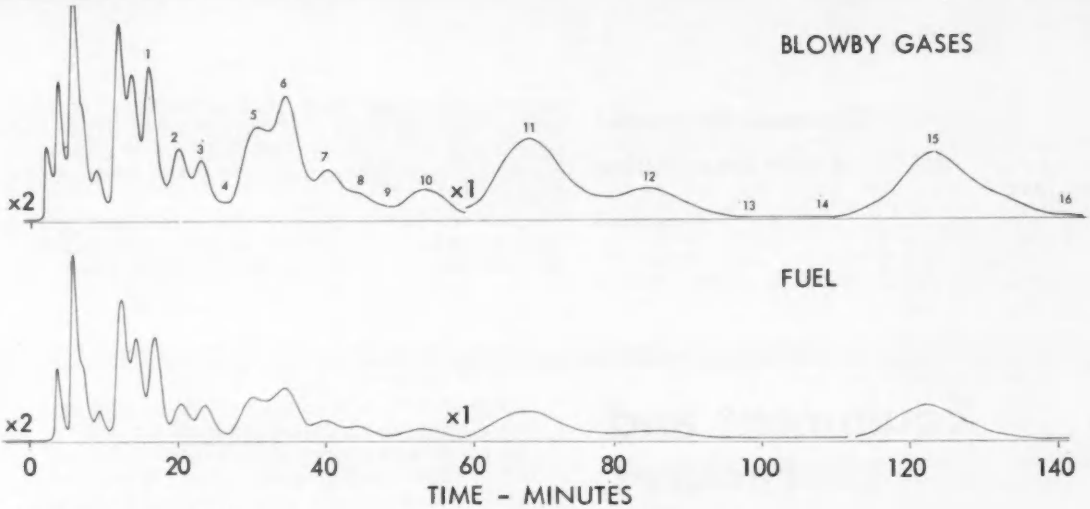
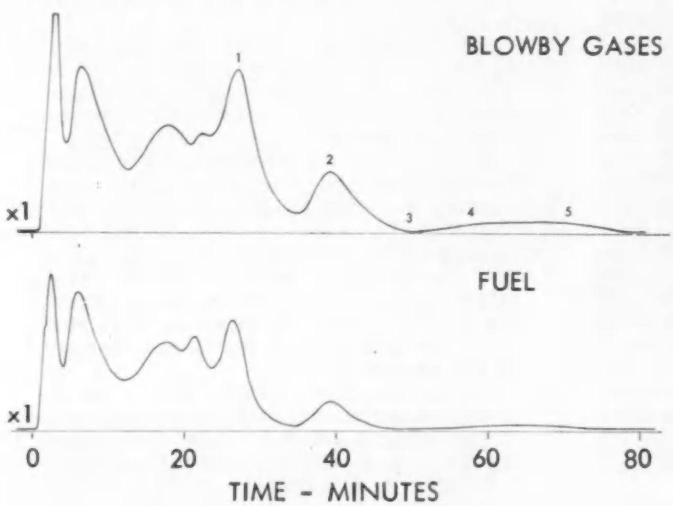


Fig. 3 — Phthalate column chromatograms. The unidentified peaks result from unseparated carbon monoxide and hydrocarbons.



1. n-Hexane, 1-Hexene, 2-Methyl-1-pentene
2. 3-Ethyl-1-butene, 2-Hexene, 3-Hexene, 2,2-Dimethylpentane, 2-Methyl-2-pentene 2,4-Dimethylpentane
3. Methylcyclopentane, 3-Methyl-2-pentene, 2,3,3-Trimethylbutane, 2,3,-Trimethyl-1-butene 2,2-Dimethyl-2-butene, 3,4-Dimethyl-1-pentene
4. 3,3-Dimethylpentane
5. 2,3-Dimethylpentane, 5-Methyl-1-hexene, 3,4-Dimethyl-2-pentene, Cyclohexane, 3-Methylhexane
6. 2,4,4-Trimethylpentane, 3-Ethylpentane, 5-Methyl-2-hexene
7. n-Heptane, 1-Heptene, Cyclohexane
8. Benzene
9. 2,4,4-Trimethyl-1-pentene, 3-Heptene
10. Methylcyclohexane, 2,4,4-Trimethyl-2-pentene, 2,2,3-Trimethylpentane
11. 2,3,4-Trimethylpentane
12. 3-Methylheptane, 2,2,5-Trimethylhexane
13. n-Octane
14. 1-Methylcyclohexene, 2-Ethyl-1-hexene, 1-Octene
15. Toluene, 2,3-Dimethyl-2-hexene, 2,6-Dimethyl-3-heptene, 2-Octene (Cis)
16. 2-Octene (Trans)

Fig. 4 — Silicone column chromatograms.



1. Benzene
2. Toluene
3. Ethylbenzene
4. m-Xylene, p-Xylene
5. o-Xylene, i-Propylbenzene

Fig. 5 — Aroclor column chromatograms.

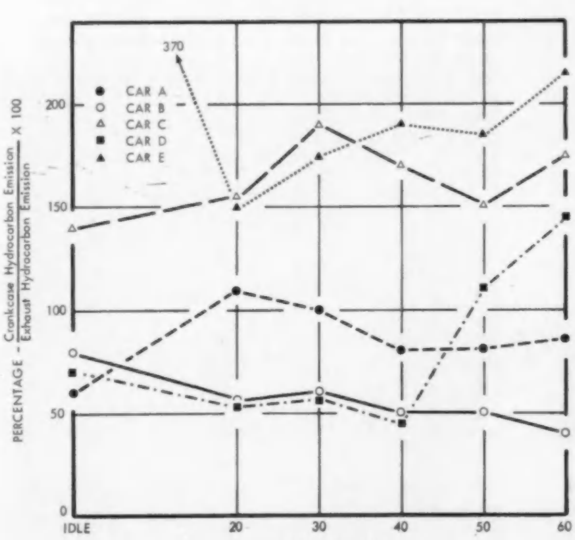


Fig. 6 — Crankcase emission rates, expressed as percentage of exhaust emission rates.

Crankcase gas causes 40 % of auto air pollution

. . . continued

denotes equal exhaust and crankcase emission rates.) Although there is a wide range in percentages (40–370%), it can be concluded that these crankcase and exhaust rates are of the same order of magnitude.

Emissions during all operating conditions must be considered to compare the relative contribution to air pollution by crankcase and exhaust gases. For

Equipment and procedures

Determing gas composition

Composition of exhaust and crankcase vent or blowby gases was determined by:

- Orsat analyses (carbon dioxide, oxygen, and carbon monoxide) of grab samples obtained before and after a combustion train.
- A Beckman L/B Model 15A infrared analyzer, which continuously measured exhaust and crankcase vent or blowby concentrations. It was equipped with an n-hexane detector and quartz optics. Due to its inability to respond to all hydrocarbon types, the values reported with the analyzer were not absolute concentrations. However, by using gas chromatography, measured Beckman concentrations were converted to absolute hydrocarbon concentrations.

Determining crankcase emissions

Of the five test cars whose crankcase emissions are discussed, cars A, B, and C are 1959 cars with widely different crankcase emission rates, car D is a 1950 car with high oil consumption, car E is a 1955 car with high blowby rates and high oil consumption.

To illustrate calculations and assumptions needed to arrive at emission rates, a portion of the data for car A at 30 mph-road load is present in Table A. For crankcase gases, the Beckman hydrocarbon concentration is multiplied by 1.25 to give an absolute hydrocarbon concentration. (The factor of 1.25 is derived from a correlation of simultaneously-determined Beckman measurements and gas chromatographic total concentrations.) Multiplying by the crankcase gas flow rate of 1.4 cfm (obtained by tracer gas technique) gives the hydrocarbon flow rate. Assuming the hydrocarbon is C_6H_{14}, and that the perfect gas law applies, gives a hydrocarbon gas density of 0.206 lb/cu ft at 90 F and one atmosphere. Hydrocarbon emission rate is then obtained as shown.

Exhaust gas data are treated similarly; however, the Beckman concentration is multiplied by 1.8 (also determined by correlation) to obtain the absolute hydrocarbon concentration.

Hydrocarbon concentrations and flow rates of the exhaust and crankcase vent gases can be compared from the table. The hydrocarbon concentration of crankcase vent gas is about 20 times that of exhaust gas. On the other hand, the exhaust flow rate is about 20 times the crankcase ventilation rate. The net effect is that the crankcase and exhaust have equal hydrocarbon emissions rates.

The hydrocarbon emission rate of car A in pounds per hour is plotted as a function of car speed in Fig. A. Data show that crankcase and exhaust hydrocarbon emission rates were about the same for each speed and load condition studied. . . . This relationship is about the average for all cars studied.

Figs. B, C, D, and E show the hydrocarbon emission rates for their respective cars.

Fig. A

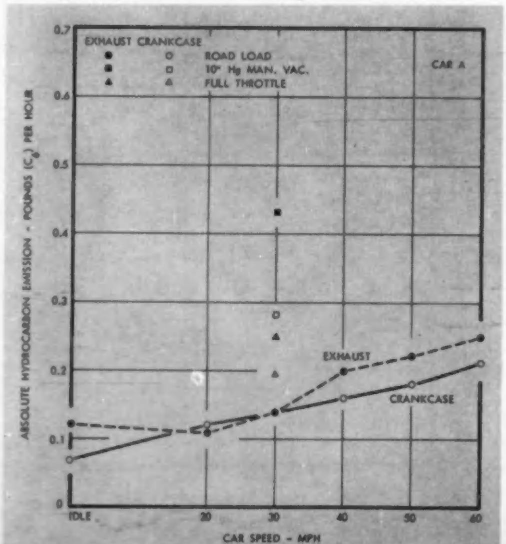
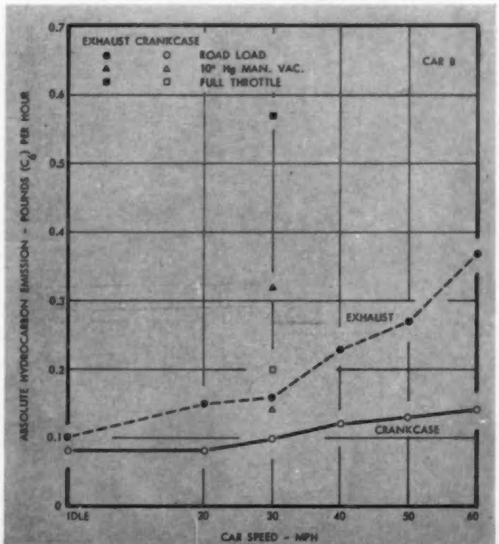


Fig. B



idle, road load, and accelerating conditions, emission rates are similar from both crankcase and exhaust. On the other hand, exhaust hydrocarbon emissions are appreciable during deceleration, while crankcase emissions are negligible because deceleration blowby rates are essentially zero.

If it is assumed that 30% of the total exhaust hydrocarbon emission occurs during deceleration, the following estimation may be made.... Deceleration emissions account for 30% of the exhaust emissions; and idle, road load, and acceleration emissions account for the other 70%. Crankcase emissions (equal to idle, road load, and acceleration exhaust emissions) are another 70%. Converting to a total emission basis, crankcase hydrocarbon emissions amount to 40% (70/170) of the entire engine hydro-

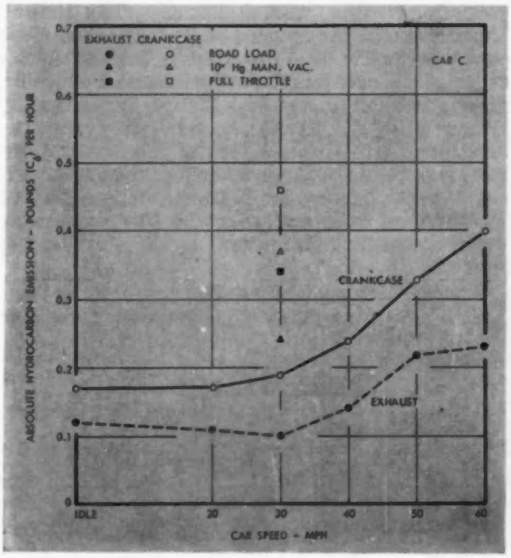


Fig. **C**

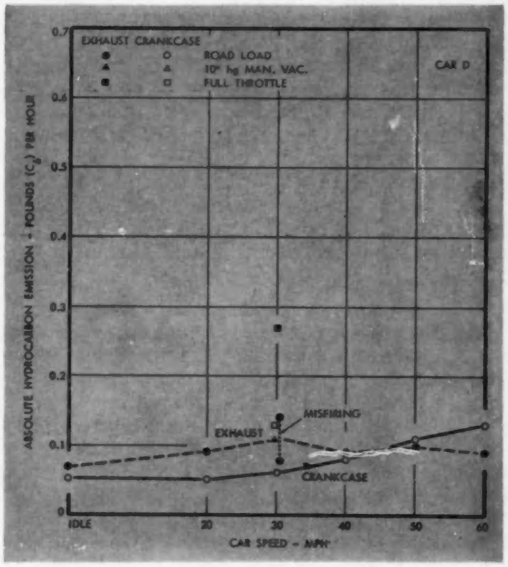


Fig. **D**

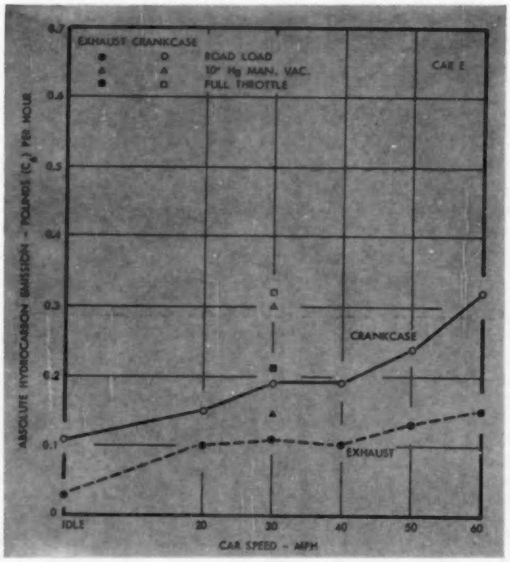


Fig. **E**

Table A — Sample Data and Calculations to Arrive at Hydrocarbon Emission Rates (Car A at 30 mph — Road Load)

Crankcase Vent Gases	
(a) Beckman Hydrocarbon Concentration	6700 ppm C_6
(b) Absolute Hydrocarbon Concentration = (1.25) × (a)	8250 ppm C_6
(c) Flow Rate	1.4 cfm
(d) Hydrocarbon Flow Rate = (b) × (c)	0.0115 cfm C_6
(e) Hydrocarbon Emission Rate = (d) × (0.206 lb C_6H_{14}/cu ft) × (60 min/hr)	0.14 lb C_6/hr
Exhaust Gases	
(a) Beckman Hydrocarbon Concentration	250 ppm C_6
(b) Absolute Hydrocarbon Concentration = (1.8) × (a)	450 ppm C_6
(c) Flow Rate	26 cfm
(d) Hydrocarbon Flow Rate = (b) × (c)	0.0117 cfm C_6
(e) Hydrocarbon Emission Rate = (d) × (0.206 lb C_6H_{14}/cu ft) × (60 min/hr)	0.14 lb C_6/hr

Crankcase gas causes 40% of auto air pollution

. . . continued

carbon emission (exclusive of carburetor vent losses). Therefore, crankcase hydrocarbon emission is a major portion of the automobile's contribution to air pollution.

Controlling crankcase emissions

One way to eliminate hydrocarbon emission from crankcases is to feed the crankcase gases back into the induction system of the engine. Fig. 7 shows a sketch of such a system. The road draft tube is replaced by an adaptor, vent valve, and a tube connected to the intake system below the carburetor.

One of the most important parts of the internal crankcase ventilation system is the vent valve. . . . It must have sufficient capacity to handle the blowby gases plus a required amount of crankcase ventilating air. However, it must control the flow so that carburetion is not upset, causing misfiring which increases exhaust hydrocarbon emission. In addition, the valve must not permit backfiring into the crankcase.

The internal crankcase ventilation system is capable of handling blowby gases under most operating conditions without upsetting carburetion. With an engine in good mechanical condition, momentary backflow of crankcase gases out the breather may occur at full throttle conditions, infrequently encountered in urban areas. With engines in poor mechanical condition — having excessive blowby — the internal crankcase ventilating system will not be entirely effective.

Internal crankcase ventilating systems for each of the five test cars were selected and tested. Fig. 8 summarizes the effectiveness of these systems in reducing hydrocarbon emissions. The reduction is expressed as a percentage of the exhaust plus crankcase hydrocarbons eliminated by the ventilation system. The greater the percentage reduction, the greater the effectiveness. Values for cars A, C, and D were 50–70%. Car B, which had low crankcase hydrocarbon emission relative to the exhaust, had 25–50% reductions. The reductions for car E were also low — especially at the higher speeds — because the blowby flow rates exceeded the flow capacity of the internal ventilation system.

To Order Paper No. 142A . . .
. . . on which this article is based, turn to page 6.

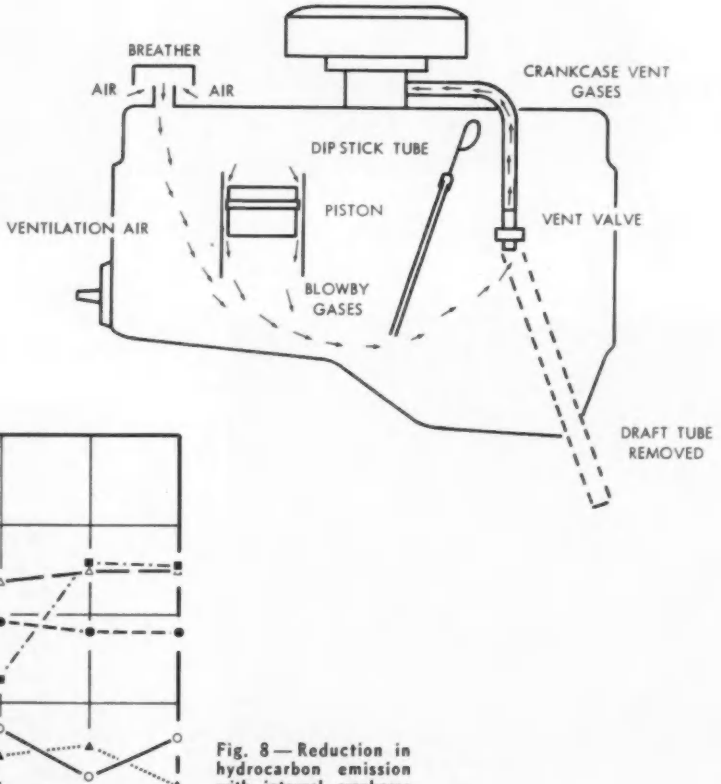


Fig. 7 — Internal crankcase ventilation system.

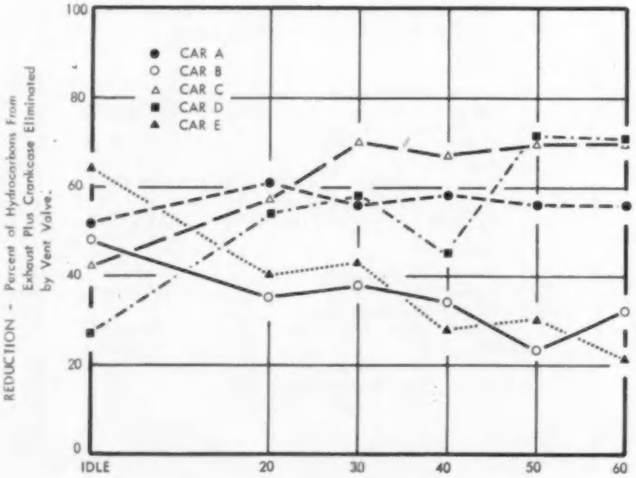


Fig. 8 — Reduction in hydrocarbon emission with internal crankcase ventilation.

Lead Contamination

—New Corrosion Villain

Tests indicate tiein between corrosion and the amount of lead present on steel surfaces.

Based on paper by **Gene L. Leithauser**
General Motors Research Laboratories

LEAD CONTAMINATION may not be the only factor responsible for steel corroding when phosphated and painted, but results indicate that lead is consistently present in higher amounts on the surface of steels that have been found to be most susceptible to corrosion.

Lead would be expected to have a tendency to inhibit the formation of a good phosphate coating and thus would produce bad results under paint. On the other hand, when exposed without phosphating or painting, the lead on the surface would be expected to retard corrosion.

An experiment was made with a group of steel panels that were sensitive to corrosion. The panels were treated as follows prior to phosphating: three controls with no additional treatment; three were immersed for one minute in 3% HNO_3; three were immersed for one minute in 3% HNO_3 followed by an electrodeposition of trace amounts of lead; and three were immersed for one minute in 3% HNO_3 followed by an electrodeposition of lead followed by immersion in 3% HNO_3. These tests showed that sensitive steel could be improved by immersion in HNO_3 but could be made poor again by the deposition of lead. Steel that was made poor by the deposition of lead could once more be improved by immersion in HNO_3.

These tests were repeated on several different samples of rimmed steel to determine whether these differences still existed. Samples from 36 heats of steels representing many manufacturers were used. They were phosphated, painted, scribed, and exposed in salt spray. In this and subsequent screenings, it was found that approximately 60% of the samples showed excessive corrosion creepage when phosphated and painted compared to about 35% showing excessive corrosion creepage in the first test.

These results were presented to the steel manufacturers, and a cooperative program was established to determine the cause of these variations.

Three additional samples of steel that were found to show good corrosion resistance and three that were found to be weak in corrosion resistance were examined for lead on the surface by the use of dithizone reagent. This analysis again revealed a higher lead content on the surface of the steel that was sensitive to corrosion when painted.

Other tests, in which several heats of steel from two suppliers were obtained before box annealing, after box annealing, and after temper rolling, showed that in each case the corrosion resistance of the steels was excellent before box annealing. After box annealing, however, some of the same steels became weaker in corrosion resistance while others were unaffected by the box annealing. In all cases, the corrosion resistance of the steels after temper rolling was much the same as before temper rolling.

These results lead us to suspect that possibly there is some contaminant on the steel that can be removed easily by the normal cleaning methods used in phosphating if the steel is processed prior to box annealing. If these contaminants are on the steel when it is box annealed, they may become imbedded in the steel in such a manner that they cannot be removed by conventional cleaning methods. Another suspect is the location of the coil when box annealed. Temperature variations in different locations in the annealing furnaces might be a factor.

In order to obtain a large quantity of steel that is sensitive to corrosion when phosphated and painted, several coils of steel were sampled and the coils retained until it could be determined which ones were sensitive to corrosion. The coil that was found to be the worst was checked at several sections throughout the coil and the results found were that the coil was uniformly sensitive to corrosion.

From this coil, over 10,000 4-in. by 12 in. panels were made. These were subjected to additional treatments in an effort to improve the corrosion resistance of the steel. A few methods resulted in a slight improvement, but in no case was the improvement as great as that obtained by either physically or chemically removing the surface layer.

Many primer systems were tested in an attempt to find a paint material that would be sufficiently protective in itself to minimize the difference in steels. The system which was found to be the most effective and eliminate most of the corrosion differences in steel, consisted of the application of an acrylic-type flash primer that is applied to the phosphated steel prior to the primer-surfacer with no intermediate baking. The flash primer is a material that is air dried for about two minutes prior to the application of the primer-surfacer.

To Order Paper No. 134A . . .
. . . on which this article is based, turn to page 6.

Missile Checkout

—No Place for

Based on report by secretary

A. O. Dority

Lockheed Missiles & Space Division

EXPERIENCE in missile programs to date indicates that, generally, missile system contractors inadequately plan and provide for integrated missile system and component testing at all levels of testing in the missile logistics pattern. So, tolerances and testing techniques are not properly coordinated. Duplication of testing and omission of important testing occurs and a lack of coordinated tests parameters criteria have been noted.

This situation can, and often does, result in the improper rejection of material and components. Interchangeability of spares replacement parts is effected and, in general, reliability and confidence factors are jeopardized. The result is the degradation of missile flight performance.

Both customer and contractor management are now becoming aware of the need for establishing integrated tolerance parameters early in a development program. And, as designs progress and flight vehicles move from the manufacturing phase to the field a compatible and integrated test plan must operate to improve the ultimate flight performance reliability.

All missile test and checkout requirements are uniquely specialized and are oriented to particular missiles, missile subsystems, schemes for missile employment, and logistics. Equipment must be designed for compatibility with the particular missile system, usually at or objectively extending state-of-the-art, and to withstand reliably a wide range of operational environment. This requirement reduces the probablity of satisfactory universal designs. Considering usage, employment, and logistics factors extending from factory through field assembly to the launching site, ashore or afloat, and the probable range in skill of operational personnel, test and checkout equipment designs should be automated to the maximum extent to reduce the opportunity for human decision to the minimum level.

This concept applies equally to solid and liquid fueled missiles and is compatible with the readiness concept of immediate retaliatory action.

Missile systems and their employment are designed to specific reliability objectives for a service and readiness life span of several years. During this period, periodic and emergency test and checkout and monitoring functions must be performed with the highest confidence to rely on measured missile system integrity or degradation. Thus test and checkout equipment reliability must be emphasized in design to include complete and compatible qualification and acceptance test specifications and valid acceptance test procedures.

The incorporation of redundency and self-check features in test and checkout equipment is desirable. In some missile systems at fixed launch sites, it is feasible to incorporate maintenance and prelaunch self-check features within the missile system itself with remote actuation and readout terminating in a centrally located control center having several launching sites in control. Such a scheme, however, would not be universally applicable for all test, checkout and monitoring functions.

Basic emphasis must be placed on:

1. The early establishment of all testing tolerance parameters.
2. An integrated and compatible test and checkout program from factory to the launching site.
3. Compatibility of test and checkout equipment designs with missile system.
4. Maximum automation and confidence factor.
5. Compatible equipment qualification and acceptance test specifications and valid acceptance test procedures.

Missile assembly, ground handling and transportation

The range of missiles considered here include both solid and liquid fueled IRBM, ICBM, and future

and Testing

Serving on the panel Missile Support Equipment, in addition to the panel secretary, were: chairman **W. F. Seedlock,** Lockheed Missiles and Space Division; co-chairman **Maj. Gen. T. A. Bennett,** USAF Office, Deputy Chief of Staff/Material, USAF; **Lt. Cdr. R. W. Smiley,** USN, Naval Inspector of Ordnance at Lockheed Missiles and Space Division; **K. J. Wein,** Lockheed Missiles and Space Division; **Leonard A. Back,** Boeing Airplane Co.; **Paul T. Nelson,** Northrop Corp.; **L. F. Muller,** Convair-Astronautics; and **H. C. Carr,** Douglas Aircraft Co.

Sloppy Planning

space probe vehicles. Logistics requirements for each basic system, and for each series of missiles of type and employment, vary widely. It has been learned, however, that precise logistics planning and operational scheduling is one of the common denominators of any measure of success.

Considering first the large solid propellant missile, which is relatively new in the field, engine production at state-of-the-art today is not abreast of what is felt to be technologically attainable ultimately in handling stability and insensitivity to environments. It is felt that this is due only to evolutionary development and that with time and experience these factors will improve. Although the situation is improving gradually, there are many problems yet to be resolved that directly affect missile assembly, ground handling, and transportation requirements.

Large masses of solid propellant in the order of tons, when cast in engine shells, contributes practically nothing to the structural strength of the powerplant. Therefore, these large masses contained in relatively thin and light weight casings are pressurized and must be handled precisely and tenderly in the missile assembly and logistics cycle to protect the mass from severe shocks, vibration environment, and over-stress point loading, either of which could cause mass distortion, propellant case bond separation, or shears in the propellant grain. Moreover these large engines must be protected from excessive thermal variations, within a median band of temperature, and from excessive humidity.

With this criteria ground handling equipment designs and protective packaging container designs, for transport and storage, must be precisely compatible. Container designs must therefore provide shock and vibration mitigating systems, heat and humidity control, and events recording instrumentation adequate for protection in any mode of transportation, that is, air, sea, rail, and truck.

Ground handling equipment designs must also be precisely compatible with powerplants, containers, and assembly fixtures to safely perform transfer operations into and out of containers for inspection and assembly and eventual delivery of complete missile to the launch site.

In the case of solid propellant missiles, all logistics operations are performed single phase with "fuel in place" whereas in the case of chemical or liquid fueled missiles, the logistics requirement does not permit mating vehicle and fuel until prelaunch countdown. Therefore, the liquid fueling problem during countdown is a continued challenge in the design of equipment and in improved operational procedure which will reduce total reaction time.

Inspection techniques for discovering flaws and discontinuities in large solid propellant engines are still being studied and evaluated. Borescopes are used to inspect interior grain surfaces, and outer case surfaces are scanned with ultrasonic devices to determine propellant-case bond integrity. Radiographic inspection is also made to discover interior voids and grain shear. Experience to date will not confirm the complete validity of any inspection technique nor the resulting data. Studies and investigations continue toward resolving correlation of inspection data with engine propulsive performance and to determine the most effective inspection technique.

In the case of large liquid fueled vehicles, the ground handling requirements are somewhat different than for the large solid missile. Fuel and vehicle shell are handled independently in the logistics pattern until finally mated on the launching site.

The unit mass weight of the missile structure without fuel is less than that for large solid missiles. The structure is very unstable horizontally and will collapse under shock or excessive vibration loading. Therefore, for ground handling, transport, and erection the vehicle shells are pressurized and supported on shock mitigating systems during transport and ground handling operations.

When the vehicle shells are erected and secured on the launching stand, fuel and oxydizer (liquid oxygen, LOX) are stored adjacent either in mobile

Missile Checkout and Testing

... continued

or fixed ground tankage. Some types of chemical fuel may be transferred to the vehicle and stored therein, however, this does not include oxydizer.

In handling, transporting, and storing liquid oxydizer extreme measures are necessary to preserve its chemical purity. It is transported and stored in dewar vacuum tankage, and in transfer operations it is pumped under nitrogen pressure through a precooled system of control valving and metering.

Since contamination in the oxydizer seriously degrades its combustion efficiency, and in some cases increases its chemical instability, all handling systems and transfer plumbing must have reliable pressure integrity. Therefore, inspection, sampling, and maintenance is necessary on a continuing basis.

When oxydizer is found to be contaminated, an auxiliary system to the missile fueling transfer system is required for purging, boil off, and replacement of loss of volume in the purging operation.

During missile fueling operations oxydizer flow rate is automatically regulated through thermally controlled bypass valving to attain system precooling at a low flow rate. As the transfer system approaches thermal equilibrium flow rates are automatically increased. Pumps are designed for constant displacement so that thermal gradients will be constant during the transfer operation when flow rates vary across the controlled by-pass loop for precooling.

The designers of chemical fuel handling, storage, and transfer systems, face a continual challenge to improve system reliability and reduce the time span for the countdown fueling operation. In looking to the future when chemical fueled missiles with upwards of 10K tons thrust, the length of which may be 300 or more feet and requiring an exotic fuel that would approximate the capacity of 500 large highway tank trucks, the ground support equipment design engineer will face an even more formidable challenge than today. In the case of nuclear fuels, which may be expected in the future, a whole new spectrum of ground support requirements are in prospect. With a nuclear vehicle, the vehicle designer as well as the support systems designer is introduced to the full range of problems imposed by a radiation environment.

Thus, engineering effort in the missile supporting systems field must be oriented toward standardization, simplicity, maintainability, and reliability. This objective will stimulate integrated logistics planning and the establishment of coordinated and compatible supporting requirements early in the missile development program thereby saving time and materials in reaching the ultimate operational phase.

To Order SP-329 . . .
... on which this article is based, turn to page 6.

Training

... need not differ from any other management training except when the individual engineer reflects too emphatically his specialized training. Then, unbalance can be corrected.

Based on secretary's report by
K. W. Hinsch
Kimberly-Clark Corp.

ENGINEERS NEED the same kind of training for management as do future executives coming up by other routes. "All development is self-development," regardless of the background of the individual involved . . . And engineers differ in capacity for self-development as much but no more than do accountants, lawyers, or graduates of university business schools.

But an engineer may reflect too emphatically the characteristics of his specialized training. Then his training for management must be modified to correct his special unbalances.

Basically, the engineer makes good management material, because he already accepted the responsibility to develop himself — when he decided to educate himself for a profession in the first place. He has already proved some dedication to self-development by completing a lengthy technical curriculum . . . often at considerable personal sacrifice. So, managements may well design their training activities to encourage self-development of all engineers . . . even though but one in three turns out to warrant such training.

Engineers are likely to do well, in fact, in development of the basic management concept that "the immediate principal is accountable for the achievement of his deputies." Having voluntarily taken some steps in his own self-development, the engineer may accept readily responsibility for encouraging self-development by those he supervises.

For this same reason, the engineer is likely to react favorably to company policies which facilitate his own further development. Typical of such policies are those which would:

- Provide job opportunities to "individual contributors" and specialists . . . when these opportunities, in both financial and nonfinancial

Engineers for Management

recognition, equal those already given to administrative management.

- Provide educational leave policies which permit advanced professional studies.
- Promote advanced research in all professional fields and include appropriate recognition for research accomplishments.

The engineer, above all others, needs a concrete definition of what is expected of him. He must know clearly and specifically the managing results expected of him, as well as the professional results expected.

And the engineer, like any other trainee for management, needs to have his performance appraised in a way understandable and acceptable to him.

Satisfactory appraisal methods for engineers will:

- Rest heavily on attainment of the clearly defined "expected results," rather than on personality traits.
- Lean toward appraisals by several people, by the man himself, and mutual appraisal by the engineer and his deputies.
- Emphasize development needs of the organization, rather than "equated evaluations" of the individual.
- Orient toward further development of recognized strengths.

For training to result in success, management must, of course, be constantly providing job opportunities where the manpower trained can be utilized. "To encourage self-development is a hollow effort if management does not intend to achieve maximum use of the manpower resources developed."

Some "engineer" characteristics can, if permitted to dominate his thinking, turn out a hindrance to his managing abilities.

An engineer's logical and factual thinking, for example, can be a disadvantage — if not subordinated to the exigencies of immediate situations. Managers often *have* to make decisions before sufficient facts are available to permit looking for the one best answer.

The engineer hesitates to accept as "facts" the conditions as they exist at the time decision is necessary. He has difficulty in seeing the lack of what he calls "facts" as the most important and dominating "fact" of all at the particular moment. He fails to see that postponing the making up of his mind is in itself decision-by-default.

To become effective in management, the engineer must come to recognize that a majority of management problems involve decision at a given time . . . on the basis of the best data then available. He must learn also that normal management thinking involves the assumption that any decision must be constantly reviewed . . . and modified as later engineer-type facts do become available.

Actually, he must recognize that management is not completing the design of a series of products as does the design engineer. Rather, it is constantly modifying and redesigning a single product — the organization's activity and its organization procedures.

Some engineers tend also to avoid in their business operations the constant, casual personal relationships by which many managers facilitate their operations. This avoidance often dilutes greatly the engineer's effectiveness as a supervisor.

Engineers, however, rate as high as those coming up by any other route in what one top executive says are characteristics of a good manager:

"A good manager demonstrates in a selfless manner, expecting justly to be taken care of. He doesn't quit nor alibi. He finds a way to solve his problems and gets to it."

Engineers get their management horizons broadened much better by being involved in facing and solving on-the-job problems than by lecture courses or school-type training. They grow fastest when their bosses expose them to consideration of management-type problems on a day-to-day basis.

Given such opportunities, the engineer progresses fastest toward management who continues to do tangible things toward self-development. Slowest progress comes to the one who consistently asks; "When is the company going to do something for me?"

To Order SP-328 . . .
. . . on which this article is based, turn to page 6.

Serving on the panel which developed the information in this article, in addition to the panel secretary, were: **Harry Hubenthal,** Electran Mfg Co.; **Boyd Payne,** Kimberly-Clark Corp.; **Norman Kobert,** Marquette University; **Donald Kirkpatrick,** University of Wisconsin.

Motor Octane Lag Sires Part–

Motor octane number is most important factor

knock in premium-

Based on paper by

H. A. Toulmin and D. L. Lenane

Ethyl Corp.

PART-THROTTLE KNOCK occurs in premium-fuel cars largely because Motor octane number of premium fuels has not kept pace with the increase in Research octane number used to satisfy the increasing compression ratios.

In the low-speed range, where most part-throttle knock occurs, Motor octane number has an effectiveness of about unity. Research octane number has little or no effect on road octane number. Fuel hydrocarbon composition has very little effect on road performance at low speed. In the high-speed range (3000 rpm), increasing the Motor octane number by one unit will increase the road rating by about two units; while increasing the Research octane number will actually decrease the road rating. These are among the more important concepts to be drawn from recent Ethyl investigations into the fundamentals of part-throttle knock.

The major importance of Motor octane number in controlling part-throttle knock is indicated by comparison of the relative importance of fuel composition on fuel ratings at both full throttle and at part throttle. In one part of this investigation, 30 fuels were rated in five 1959 cars. These were standard, except that compression ratios were raised slightly to insure that the fuels would be evaluated at ignition times very close to standard. (Table 1 shows the average, high, and low laboratory qualities of the test fuels used.)

Effects Shown by Comparisons

Table 2 gives a comparison of the coefficients for full throttle and part throttle.

Comparison of the *d* and *e* (olefin and aromatic) coefficients at full throttle and at part throttle indicates that a decrease in olefin content or an increase in aromatic content will increase the road rating at either test condition. A change in fuel composition has equal effect at full throttle and at part throttle at 2000 rpm. At 3000 rpm, however, a change in fuel composition will change the road rating slightly more at part throttle than at full throttle.

Engine speed effects

Fig. 1 shows the effect of engine speed on the Research and Motor octane-number coefficients at both full throttle and part throttle for one car.

The Motor coefficient increases and the Research coefficient decreases with engine speed for both rating conditions. The part-throttle Research and Motor coefficients at 1500 rpm are about equal to the full-throttle coefficients at 3500 rpm, as shown by the dotted lines. This indicates that the engine is as severe during part-throttle operation (12 in. of Hg) at 1500 rpm as it is during full-throttle operation at 3500 rpm. A similar situation was found for the other engines used in this program.

Programs compared

Fig. 2 shows results of rating two series of fuels — one with a constant Research rating and variable Motor octane number; the other with a constant Motor rating and a varying Research octane number.

A comparison of this program with another in which 30 selected fuels were rated — and the resulting data analyzed by regression analysis using an electronic computer — is shown by Fig. 3. Here the road octane numbers were calculated for the fuels used in the first program from the average

Throttle Knock

in controlling part-throttle

fuel cars, study shows.

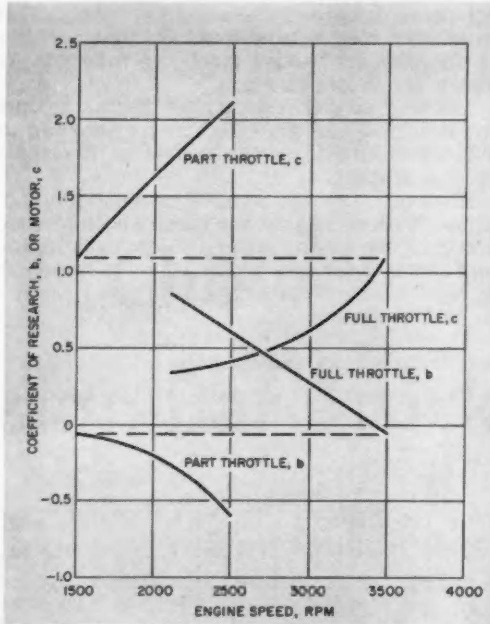


Fig. 1 — Comparison of full- and part-throttle coefficients for one high-compression 1959 car.

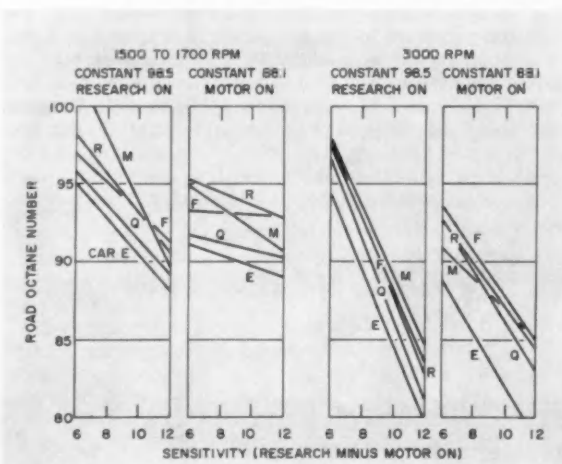


Fig 2 — Part-throttle fuel ratings of two series of fuels — one with a constant research rating and variable motor octane number; the other with a constant motor rating and a variable research octane number.

Table 1 — Characteristics of Fuels Used for Part-Throttle Knock Rating

	Average	High	Low
Research Octane Number	100.2	103.7	95.8
Motor Octane Number	90.3	96.5	87.2
Sensitivity	9.9	11.7	7.2
Olefins, vol %	19.0	37.0	5.0
Aromatics, vol %	29.0	45.0	5.0

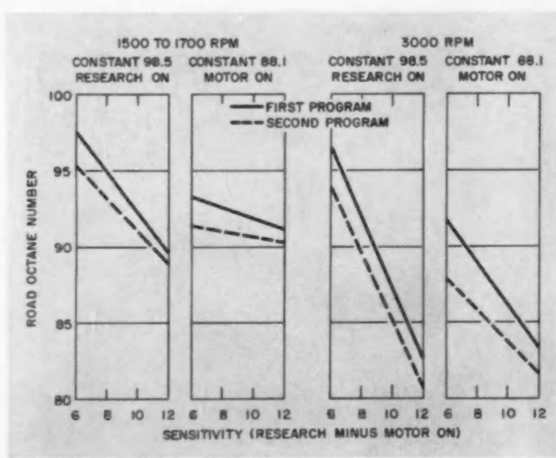


Fig. 3 — Comparison of fuel rating from two part-throttle knock programs (average of five cars in each program).

equations derived in the second program. It is these calculated road octane numbers that are compared to the average values from the original program, which are shown in Fig. 3.

The comparison reveals that the fuel ratings from the first program were slightly higher than the calculated values from the equations derived in the second program.

However, the lines have essentially the same slopes, indicating that the cars in both programs reacted in the same manner to changes in Research and Motor octane numbers. This is to be expected, of course, since four of the five cars were the same in both programs.

Part-throttle knock now a problem

In any discussion of part-throttle knock it might be asked why has part-throttle knock only recently become a problem when there was no problem in the past? Probably the increase in fuel sensitivity as Research octane number has been increased has been primarily responsible.

Fig. 4 shows the trend to greater premium-gasoline sensitivity as Research octane number has been increased. As engine compression ratio has moved up to take advantage of higher octane numbers, the Motor octane number, which controls part-throttle antiknock performance, has not kept pace with the increase in Research octane number.

A comparison of distributor advance characteristics of four 1954 and 1959 V-8 engines indicates that the engine manufacturer is now starting the vacuum advance mechanism at 2¼ in. higher vacuum and is using 7 deg less vacuum advance at 12 in. of manifold vacuum than he did previously. This retard in the vacuum advance has been a compromise to alleviate part-throttle knock in current engine designs.

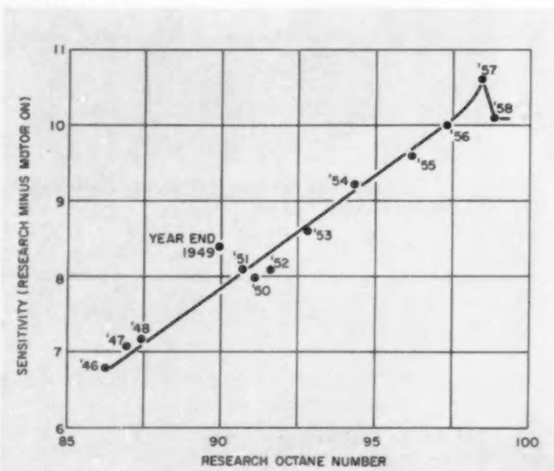


Fig. 4 — Trend toward increase in gasoline sensitivity. Average research octane number of U. S. premium gasolines.

Part-throttle knock effects

Part-throttle knock usually occurs in the load range between 8 and 14 in. of manifold vacuum, and is most prevalent at low engine speeds. It can be alleviated either by changes in either the engine or the fuel properties.

The most effective engine change is a reduction in the vacuum spark advance in the critical knocking range. This usually involves retarding the vacuum advance in ranges other than just the critical knocking ranges. Usually, the retarding will not affect fuel economy at road load. However, it *will* reduce economy at intermediate loads and, in some cases, will adversely affect the part-throttle response or "feel" of the engine. Since a considerable proportion of the customer's fuel is used during part-throttle acceleration, tank fuel economy will be adversely affected.

To Order Paper No. 128T . . .
. . . on which this article is based, turn to page 6.

Table 2 — Comparison of Average Coefficients* at Full and Part Throttle

Equation Form	2000 Rpm, Full Throttle a	b	c	d	e	3000 Rpm, Full Throttle a	b	c	d	e
(3) a,R,M,O	13.5	0.66	0.23	- 0.029		31.5	0.31	0.41	- 0.073	
(4) a,R,M,A	11.8	0.52	0.40		0.023	27.2	0.01	0.76		0.047
	2000 Rpm, Part Throttle					**3000 Rpm, Part Throttle**				
(3) a,R,M,O	- 9.8	- 0.16	1.30	- 0.027		- 10.2	- 0.42	1.57	- 0.092	
(4) a,R,M,A	- 11.4	- 0.30	1.45		0.023	- 15.8	- 0.87	2.09		0.059

* Road octane number = $a + c\,(M)$ (1)
Road octane number = $a + b\,(R) + c\,(M)$ (2)
Road octane number = $a + b\,(R) + c\,(M) + d\,(O)$ (3)
Road octane number = $a + b\,(R) + c\,(M) + e\,(A)$ (4)

where:
M = Motor octane number
R = Research octane number
O = Olefins, vol %
A = Aromatics, vol %
a, b, c, d, and e are constants dependent on the test car and rating speed.

Chevrolet's Torsion-Bar Truck

. . . has independent front suspension and tailored-to-fit steering linkages.

Excerpts from paper by

H. O. Flynn

Chevrolet Motor Division, GMC

NEW TORSION-BAR CONSTRUCTION adopted with the independent front suspension on Chevrolet trucks is accompanied by a steering system specially tailored to assure directional control at all times.

The suspension system design is such that the entire suspension unit can be preassembled, with the proper castor and camber before being assembled into the vehicle.

Torsion bars

The torsion bar springs were chosen because:

a. They store about four times as much energy per lb of steel as do leaf springs.
b. Coil springs which could be fitted into the space available on heavy-duty models couldn't give the necessary carrying capacity.

The torsion bars are being made of manganese chrome steel, heat-treated to Rockwell C 47–50. The material is SAE 5160.

The bars are centerless-ground to size. Then the hexagon ends are upset in their correct angular relationship before prestress. Next, they are heated in a controlled atmosphere furnace, to control the decarburization — and are straightened if necessary. Magnetic particle testing detects any faults.

After shotpeening, the bars are preset . . . . by applying torque in the same direction as the normal load operation of the bar to about 7% above the maximum operating stress.

Preset strain equals 0.022 in. per in., with permanent set-strain of about 0.008 in. per in. Thus, prestressing produces an angular set in the bar of about one-third the total presetting angle. This serves to increase the elastic limits by raising the yield stress in the direction of the preset, increasing the strength and durability of the bar and reducing sagging.

The load deflection and stress distribution which occurs during prestressing is indicated by the following example (from SAE's manual, "Design and Manufacture of Torsion Bar Springs"), which uses a theoretical bar of 2.27 in. in diameter, 72.7 in.

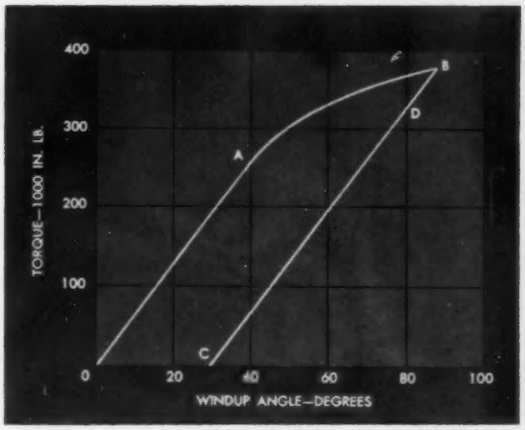


Fig. 1 — Load-deflection during presetting of a torsion bar spring.

Chevrolet's Torsion-Bar Truck

. . . continued

active length, with a torsional rate of 6900 in.-lb per deg.

Note that the load-deflection diagram (Fig. 1), shows prestressing of the bar begins at point zero and shows a linear increase in torque corresponding to its rate, up to point A. There, partial yielding occurs, with the torque building up more slowly for each degree of bar windup.

Point B represents the maximum safe torque and windup. As the load is removed, the torsion bar returns elastically from point B, along a linear decrease to point C. The torsional rate, however, is now somewhat reduced.

At point B, all material in the bar is either at the yield point or below. So, as long as operational torques do not exceed the windup torque at point B (point D, for example being maximum), the bar will operate elastically along the line BC, with at least a 20-deg greater possible windup before the yield point is reached than before prestressing.

Because Chevrolet's operational windup is but a small fraction of the prestressing windup, several self-evident benefits accrue. Since partial yielding in prestressing does not occur instantly, Chevrolet specifications require that the bar be wound up to point B at least three separate times.

The prestressing operation also serves as an excellent inspection procedure in disclosing laps or

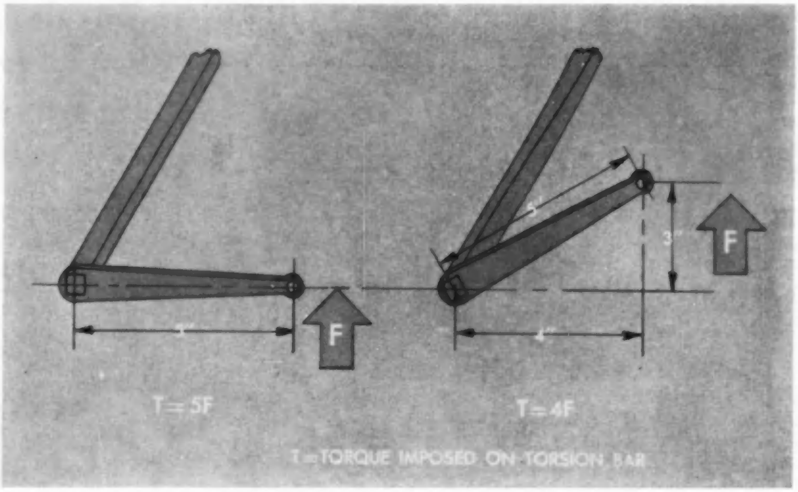


Fig. 2 — Variable-wheel-rate principle is inherent in torsion bar spring arrangement. Variable rate is provided by harmonic displacement of control arm which changes the constant rate of the torsion bar into sinusoidal wheel-rate at the ground.

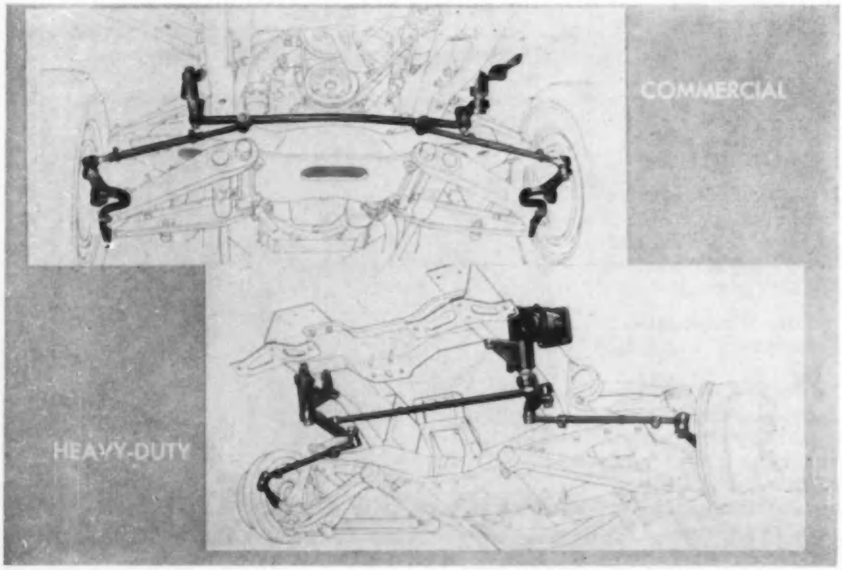


Fig. 3 — Commercial and heavy-duty steering systems on Chevrolet trucks which use a torsion-bar independent front suspension.

seams in the steel . . . or improper heat-treatment. The latter would show up in inconsistent or inadequate spring-return, following the preset load application.

The preset angle must be very closely controlled to hold consistent end-indexing within satisfactory limits. (End-indexing controls the vehicle height). Because of the hex offset, improper installation is practically impossible, even though the bars have become right-hand and left-hand.

Three separate coats of paint protect the torsion bars against corrosion.

The variable-wheel-rate feature, which softens shocks in a shackled leaf spring, is inherent in the torsion bar arrangement, while absent in most independent front suspensions of coil spring design (see Fig. 2).

Variable rate is provided by the harmonic displacement of the control arm, which changes the constant rate of the torsion bar into sinusoidal wheel rate at the ground.

In function, the suspension control arm forms a lever arm about the torsion bar, to which it is attached. Variable wheel rate is the result of the shortening of the effective lever arm as it moves above or below the horizontal plane. If the control-arm length is assumed to be a convenient 5 in., the torsion bar is subjected to a torque value five times the force, where the lever arm is in a horizontal position and the force directly upward.

As the control arm moves upward in jounce, the effective lever-arm length is reduced to, maybe, 4 in., and the torque value becomes only four times the force. Thus, with identical torsion-bar rates the wheel rate would be 20% greater at this particular position in jounce.

In practice, however, the commercial model control arm at curb load is below horizontal, and the wheel rate increase is approximately 19% in jounce.

Steering system tailored

The steering linkage is tailored to offer little or no restriction to wheel movement, yet assure directional control at all times.

A parallelogram steering linkage for both the commercial and heavy-duty models provides a system where, under identical conditions, the steering action of one wheel is the same as the other. Forward steer was adopted due to space requirements.

Several linkages were designed and studied before decision on the production designs shown in Fig. 3.

In the earlier design shown in Fig. 4, the relay road was located in front of the steering gear so that the pitman and idler arm-ends transcribed the same arcs as the steering arm.

This arrangement provided the greatest ratio buildup on turns, but had to be abandoned because it forced the relay rod so far forward of the outer pivots that tie-rod angularity to the centerline of the lower control arm was 20 deg. This angularity made the tie rod fight the deflection of the rubber-bushed original suspension and was a factor in its being discarded. To reduce the tie-rod angularity, the relay rod had to be offset 4.5 in. This offset — and the fact that the steering still needed improvement — resulted in another complete redesign.

A second of the earlier design (shown in Fig. 5) was a bell-crank system. This incorporated double-ended pitman and idler arms and parallel tie rods.

This arrangement provided the theoretical Ackerman by locating the tie-rod inner pivots inside the centerlines of the idler and pitman arm. But testing revealed a marked lack of rigidity between the wheels, with some large stresses imposed on the idler bushings. Another peculiarity of this par-

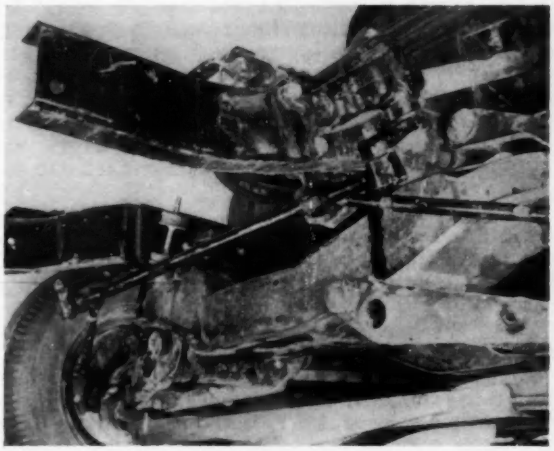


Fig. 4 — Experimental steering system tested during development for Chevrolet trucks.

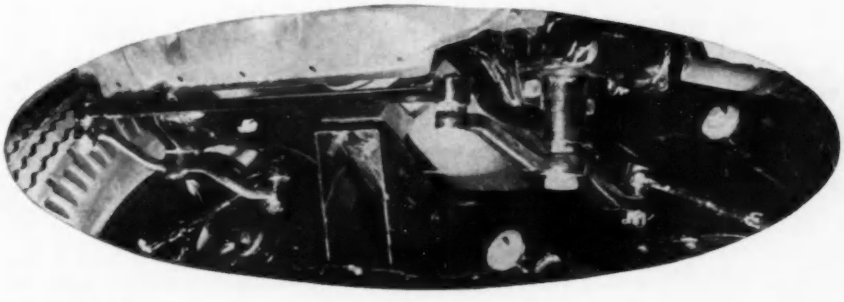


Fig. 5 — Another experimental steering system tested during development for Chevrolet trucks.

Chevrolet's

Torsion-Bar Truck

. . . continued

ticular system resulted in right-hand wheel wobble in a left turn, after the tires became corner-worn.

At this stage, the heavy-duty truck had one major steering-linkage design overhaul because of space requirement changes involving steering-gear positioning. The basic design, however, was not altered appreciably.

The production commercial model steering system (Fig. 3) has the relay rod pivoted at the pitman and idler arms of nylon and rubber, greased-for-life bushings. Tie rods are attached to the relay rod of these bushings through conventional metal inner pivots. The tie rods extend forward at about a 4-deg angle and attach to the steering arm bosses. While tie rods, which have angular relationship to the centerline of the control arm, are undesirable, small angles are tolerable. In this case the give is about 1 deg of additional toe-out in full turn.

Heavy-duty models have similar linkage, except for the necessary differences for strength and Ackerman. These include double bosses for the pitman and idler arms. The outer boss is located on the centerline of the pitman shaft and the inner is offset. The relay rod, which has metal socket assemblies, is attached to the outer bosses so that parallelogram articulation occurs. The adjustable tie rods, also made with socket assemblies are located by the inner bosses.

Because of these variations between the commercial and heavy-duty models, two different Ackerman steering layouts are used. With a front mounted steering system, there is some difficulty designing for a theoretical Ackerman, unless a prohibitive wheel offset is used, because the angle of the steering arm is limited by the wheel.

It was found that 50 or 60% less than the correct condition was entirely satisfactory for the commercial trucks, because of the relatively light front end loads. Since the heavy-duty trucks operate with heavier front end loads, lower speeds, larger tires, and smaller slip angles, however, it was felt that any great departure from the theoretical Ackerman would result in tire scrub . . . and even in damage to the road surface under certain conditions.

So, for the heavy-duty models, the overlapping position of the tie rods in relation to the relay rods is such that movement of the pitman and idler arms in turning the wheels causes a lengthening of the inside tie rod and a foreshortening of the outside tie rod.

This, of course, provides a greater wheel angle and the theoretical Ackerman can be designed from considerations of the degree of tie-rod and relay-link overlap.

. . . To Order Paper No. 121T
. . . on which this article is based, turn to page 6.

Precision Improves Cuts

Based on paper by

Ralph T. Buscarello

Stewart-Warner Corp.

PRECISION balancing of truck engines to tolerances as close as those of racing engines has brought excellent results. Bearing life of high-speed engines has been increased as much as 300%. Commercial truck engines, operating at lower speeds, have shown increases of 25–100% in life between teardowns. And horsepower and acceleration have risen about 10%.

Technique of piston balancing

Precision balancing calls for recording the weight of each piston, then bringing the weight of each down to that of the lightest one. The tolerance is plus 0.5 g minus 0. Truck pistons usually have a commercial tolerance of 6–15 g, while passenger-car pistons will vary from 6–8 g between the lightest and heaviest units. The piston is made lighter by removing metal from the inside of the skirt.

Connecting rod balancing

Connecting rods have to be balanced as a total rod and also end for end. All rotating ends should be brought to within 0.5 g of each other, and the same holds true for the piston pin ends. Each end must be balanced separately because the reciprocating end has a different effect on the crankshaft from that of the large end. New connecting rods of commercial engines vary in weight from 8 to 20 g, while the weight of rebuilt rods may vary as much as 30–40 g. Often, they are so far out of balance that there is not enough material to be removed to effect a balance. Metal is removed from balance pads, usually found at each end of the rod.

Use of bob weights

The effective weight of the rod and piston assembly affects the dynamic balance of the V crank-

Balancing of Rebuilt Engines Performance and Maintenance

shaft, even if the crankshaft is not modified during rebuilding. For this reason, the rebuilder has to weigh and record a complete set of rings, piston pins, rod insert bearings, and even the pin locks.

A bob weight replaces the rod and piston assembly during the balancing of the shaft on a balancing machine. Each bob weight is brought to the exact computed weight and is then clamped onto each individual throw. The bob weight is 100% of the rotating weight about each throw plus 50% of the reciprocating weight affecting that throw. After mounting the bob weights, the V shaft can be balanced in the same manner as an in-line crankshaft. In-line crankshafts can be balanced without bob weights.

The 71 series GMC diesels require bob weights for crankshaft balancing, but in this case the bob weight is 100% of the rotating weight only, the reciprocating weight being taken care of by rotating counterweights apart from the crankshaft.

Rotating part balancing

Commercial-job-type balancing machines are necessary for balancing rebuilt engines to precision tolerances because the same balancer must be capable of balancing the largest crankshaft as well as the smallest pulley. The crankshaft is usually balanced first, then the flywheel is mounted on the balanced shaft and balanced to the same tolerance. Next, the clutch is mounted in place and balanced in the same manner, followed by the torsional damper at the other end. With proper mandrels, the flywheel and clutch can be balanced individually, apart from the crankshaft, enabling easier handling.

Tolerance for rotating parts

The average commercial engine crankshaft appears to have a balancing tolerance of about 1 or 2 oz-in. In precision balancing it is less than 0.1

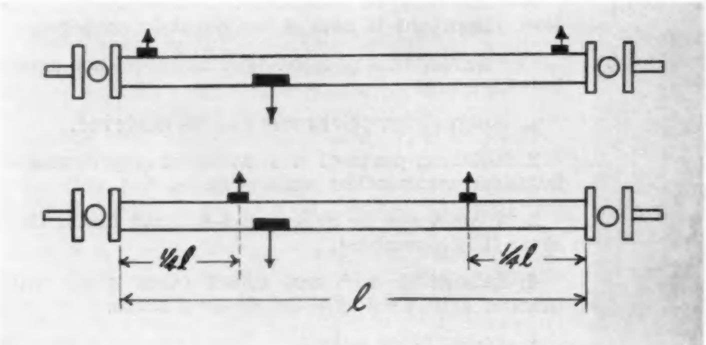


Fig. 1 — (Upper view) Long distance between unbalance weight near axial center of driveline and counterbalancing corrections in end planes causes deflection of rotor at operating speed. Proper balancing is shown in lower view. Note that best results are achieved by dividing long rotor into three parts and making corrections in the two inside planes. In this manner, distance between any unbalanced weight and the counter-balancing weights is never very great relative to rotor diameter.

Balancing of Rebuilt Engines

. . . continued

oz-in. Decreasing the unbalanced state of the rotating part decreases the centrifugal force, which causes the engine to vibrate and wear out parts. High speeds and super highways make vibration a source of real driver discomfort and outmode the tolerances acceptable only a short time ago.

Balancing drivelines

Fig. 1 (upper view) shows a long driveline with an unbalance weight near its axial center. For sake of convenience the end planes would usually be chosen for correction. But the long distance between the unbalance weight and the couterbalancing corrections in the end planes causes a deflection of the rotor at operating speed. The rotor is deflecetd in the same direction as the original unbalance weight causing further unbalance, while the end plane corrections cause less deflection but result in insufficient correction. If the shaft were short and rigid, this deflection would be negligible and the rotor would run smoothly.

Better results are obtained by dividing the long rotor into three parts, as shown in the lower view of Fig. 1. Static and dynamic balance corrections are then made in the two inside planes. Thus, the distance between any unbalance weight and the counterbalances is never great relative to the rotor diameter.

Drivelines can also be balanced in the vehicle, using a commercial portable balancer. This method takes into consideration all of the effects of misalignment as well as actual unbalance. Care should be taken not to get the shaft too hot with an arc welder, as this would cause the shaft to bend and give an erroneous reading. Some operators tack-weld the counterbalancing weights on and then run a bead exactly opposite the position to get equal heat on the other side. For trial runs, aviation-type hose clamps are used to hold washers in place. The washers are then weighed and a permanent counterbalancing weight substituted.

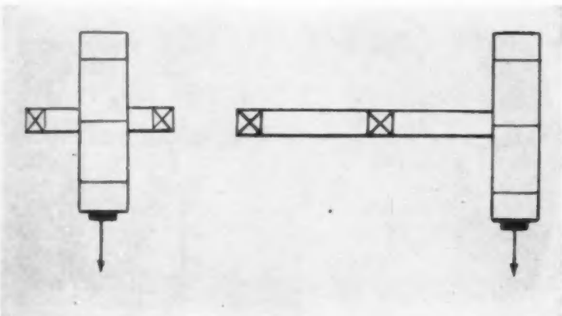


Fig. 2 — Pump impeller at left is mounted between bearings and has a small amount of allowable unbalance. Same pump impeller with unbalanced condition and mounted as shown at right may vibrate excessively. Kinetic balance tolerances should be 5-10 times closer than for pump mounted between bearings.

Tolerance for flexible rotors

In the case of a rotor mounted in a cantilevered position on the end of a shaft, the kinetic balance tolerance would have to be 5–10 times closer than when mounted between bearings. Fig. 2 (left) shows a small amount of allowable unbalance with a pump impeller mounted between bearings. At the right is the same impeller and unbalance condition with mounting which may cause excessive vibration. When a balanced part still vibrates, the mounting should be examined, as it may be the cause of the vibration. The trouble can be removed by decreasing the balancing tolerance.

Use of portable balancer

Balancing can often be done faster with a portable balancer than with the cradle balancer thus far considered. Portable types are available that indicate the frequency of the offending vibration and its amplitude. With this information the vibration can be measured at each end of the crankshaft, at the fan assembly, and at driveline bearings. Noting the frequency and amount of the worst vibration will pinpoint the main source of trouble. The portable balancer will also tell whether the vibration exceeds a predetermined acceptable amount.

The advantages of a portable balancer for maintenance, are:

1. A part can sometimes be balanced in less time than it would take to remove the part.

2. The part requiring balancing can be singled out.

3. Excessive vibration can be determined before attempting to balance.

4. Vibration sources other than the rotor can be balanced.

5. Final balance is obtained in assembled condition, important if part is inaccurately centered.

The advantages of a job-type maintenance cradle balancer are:

1. Much closer tolerances can be achieved.

2. Rotating parts of a dismantled engine can be balanced while other work is done.

3. A rotor can be balanced 4–6 times faster than after it is assembled.

4. Balancing does not affect other parts with grinder grit, weld splatter, or drill chips.

5. Accessibility is better. Parts cannot always be reached with a portable balancer.

6. Training an operator is easier.

To Order Paper No. 114T . . .
. . . on which this article is based, turn to page 6.

Abridgment of an
SAE Indiana Section Paper

Combating Exhaust System Corrosion

Based on paper by

Tom Danner

Arvin Industries, Inc.

RESEARCH, prompted by the unsatisfactory life of exhaust systems, which reached a peak in the years 1955–1958, has uncovered basic causes of corrosion and led to the singling out of materials which can increase the life of exhaust system components substantially.

The combustion of present-day fuels forms sulfuric, sulfurous, hydrochloric, and hydrobromic acids — all of which are highly corrosive to metals. The sulfuric and sulfurous acids come from the sulfur content of the gasoline; the hydrochloric and hydrobromic acids are due to the additives in the fuel — the tel and ethylene dybromide. Since there are highly corrosive acids in the exhaust system and because of the amount of water vapor which also condenses at temperatures below 200 F, there are acids in the muffler with a Ph of about 2.5.

Effect of temperature

Examination of mufflers which have failed in use showed certain parts to have corroded faster than others. Accordingly, a study was undertaken to determine the role temperature range plays in corrosion. There were found to be two ranges at which corrosion was most severe — around 180 and 900 F. Since most muffler parts do not reach the 900 F range in normal use, the 180 F figure is the significant one.

This temperature is the one at which the condensate boils, that is, a condensate of at least one of the analyses made. The highly corrosive range was where the liquid was vaporizing, as borne out by the fact that, with the test panels submerged in condensate and maintained at a temperature of 180 F, the maximum corrosion took place at the interface, or right at the liquid-vapor level. Below that temperature corrosion was not excessive; above it the condensate is completely vaporized and is driven from the exhaust system without contact with the muffler parts for any length of time.

The way a car is used has much to do with muffler and exhaust system life. Short runs create the worst situation for long life. Some parts of the muffler may reach fairly high temperature while others do not and so remain in the highly corrosive temperature range for longer periods of time. With long runs, all of the parts reach a steady state of temperature, above 180 F in most cases, so that all of the condensate is driven as vapor and corrosion is minimized. The problem then is to design mufflers to take care of any driving habits.

Choice of materials

To evaluate materials for muffler construction, specimens have been tested in an accelerated corrosion test box. The temperature of the box is maintained at 186 F and the condensate used is acquired by burning the fuel in an engine. Since fuel varies from season to season and brand to brand, it is necessary to check against control panels of known materials. These are usually plain carbon steel, aluminized steel, and type 430 stainless steel. The test is run 600–800 hr to evaluate the material to destruction or to the destruction of some known material. Tests using synthetic condensates and measuring weight losses have not proved completely reliable.

Following laboratory tests, mufflers are constructed of the promising materials for road testing, and from these combined tests three materials have been selected as worthy of recommendation. They are zinc-coated or galvanized steel, aluminized steel, and type 430 chrome steel.

The zinc coating should be of the hot-dipped variety since electroplated zinc has proved unacceptable for preventing muffler corrosion. Where driving habits make for very short muffler life, zinc-coated steel can increase life by as much as 50–75%. The quality of the coating and the design of the muffler are very important, otherwise the advantages may be lost.

Aluminized steel should increase muffler life from 60–100%. Its heat resistance is better than plain steel, making it useful for high heat applications such as are found in trucks. Its cost is almost twice that of plain steel when used in an entire muffler. On dual exhaust systems, aluminized steel mufflers should last up to two years, and on single systems from 2½ to 4 years without any problems.

Tests of chrome steel show that the chrome content must be above 14% to make a material satisfactory for mufflers. Therefore, most of our stainless steel mufflers have 430 wherever it can be used, and one of the 300 series for parts where 430 is not adaptable. This material costs in the neighborhood of 50¢ per lb and will not be used extensively unless the lower priced materials are found to be unsatisfactory.

To Order Paper No. S212 . . .
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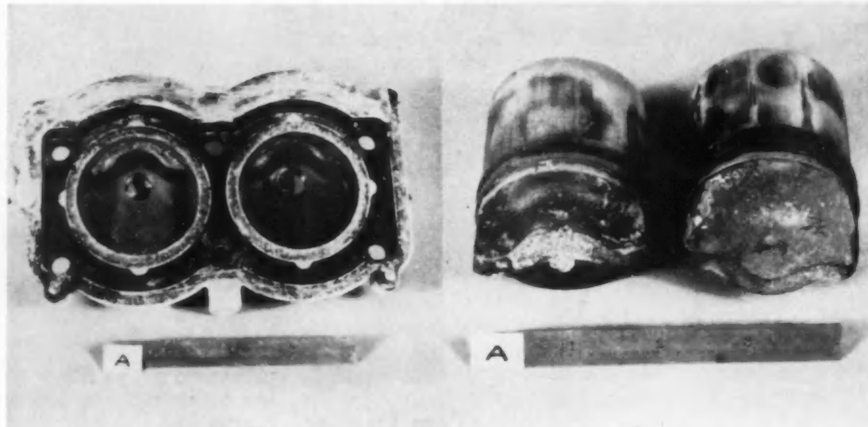

Fig. 1 — Combustion-chamber deposit in an outboard engine after a 100-hr, full-throttle run, using a base oil with 2% ash-forming additive.

Wanted—

Better Spark Plugs for Portable 2-Stroke Engines

Based on paper by **Lowell E. Haas**
McCulloch Corp.

THE SATISFACTORY performance of portable 2-stroke engines is being thwarted by short spark-plug life and runaway preignition, which accompanies the high specific output and low weight of these engines.

Laboratory tests of over 400 plugs in eight sizes and in four brands of engines ranging in horsepower from 5.5 to 70 have shown plug life to average 32 hr before failure and the range is 0.2–100 hr. The failure involves many things — cold fouling, lead fouling, bridging, missing, and refusal to start a cold engine.

Short plug life adds to the cost of engine operation. Preignition prevents the engine designer from getting a still higher output per cubic inch of engine displacement. Some outboard engines are now certified at 0.94 hp per cu in. In 1958, there were four engines exceeding this figure; in 1959 there were none. Now that 4-stroke engines have had their compression ratios pushed to the point of meeting preignition, perhaps the common problem will spur fuels and lubricants research to reduce preignition, just as it helped to reduce knock and the limits that knock imposed.

Observations on preignition

Preignition takes two forms. One advances the time of ignition to a more or less constant point and remains there, causing the engine to slow down, just as it does when the spark is overadvanced. The other — runaway preignition — continues to advance ignition ever earlier and results in destruction of engine components.

The spark plug is the focal point for preignition in 2-stroke engines. Observations reveal it to be the hottest part of the combustion chamber. Moreover, eliminating sharp corners or polishing combustion-chamber surfaces has no effect on the preignition tendencies of a clean engine, whereas a plug which is preignition prone will induce preignition in a clean engine. When a colder heat range plug is used, preignition becomes harder to incite. But if the cold heat range is obtained by shortening the heat path, then the result will be a shorter fouling

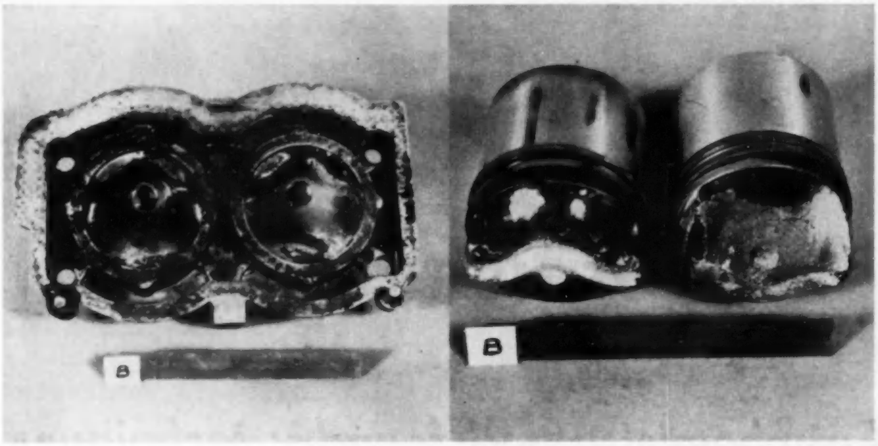

Fig. 2 — Combustion-chamber deposit is reduced in volume and the deposit is soft and oily when the lubricant used is a base oil with 3% ashless additive. Compare it with the deposit shown in Fig. 1.

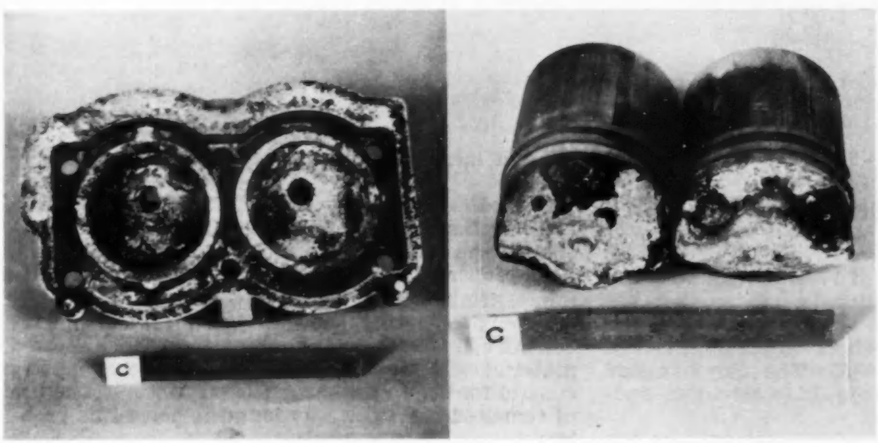

Fig. 3 — When a base oil without additive is used, the combustion-chamber deposit at the close of a 100-hr, full-throttle test run is about double that shown in Fig. 1.

path and also decreased plug life.

Environmental effects

The contribution of fuel composition to the environment surrounding the spark plug is unknown and beyond the scope of our laboratory to determine. Some runs were made with LIB fuels, CRC reference fuels, and especially blended gasolines to find a reference fuel of known preignition tendencies which could be used to evaluate the effect of design changes. The data obtained indicate that much could be learned in an oil company laboratory about the effect of olefins, aromatics, and saturates which would reduce preignition and lift some of the stigma from the spark plug.

Lubricants and their additives can change drastically the conditions under which spark plugs operate. Two-stroke engines once used the same lubricants put into automobile engines. Then came the metallic additives which improved 4-stroke engine performance but quickly plugged ports and built large volume deposits on combustion-chamber surfaces in 2-stroke engines. This prompted manufacturers of outboard engines to specify uncompounded oils. As specific outputs were increased and the limitation of preignition began to be felt, work was started to find additives which were tailored to the 2-stroke engine. The tremendous work of the oil companies has led to the development of metallic and ashless detergents which will change combustion-chamber deposits. This fact is confirmed by Figs. 1, 2, and 3, which show combustion-chamber surfaces after 100-hr, full-throttle tests of oils in an outboard engine.

What oil tests tell us

Tests reveal that the new, metallic, ash-forming additives will reduce combustion-chamber deposit volume to about one-half that of straight-run oils, but the deposit is still a hard, uniformly laid down one. Ashless detergents, on the other hand, will reduce the volume and change the character of the deposit to one of a soft and oily nature, which passes out of exhaust ports more easily. Deposit throw-off is also reduced.

To Order Paper No. 123U . . .
. . . on which this article is based, turn to page 6.

Structural 17-4PH

—but chemistry and foundry techniques

Based on paper by

W. R. Roser and K. E. Kuschell

Norair Division, Northrop Corp.

INVESTMENT CASTINGS of 17-4PH steel alloy are being used as prime structural components in the T-38 supersonic jet trainer. Castings are produced to Norair specification which is, to all intents and purposes, identical to AMS 5355. The alloy has good corrosion resistance properties, high strength, ductility, and castability.

Investigation of castings being received from the foundries showed that they were adequately strong, but, in most cases, did not meet ductility requirements. Metallographic analysis revealed the major causes of this low ductility — microshrinkage (Fig. 1), and large amounts of dendritic-shaped ferrite (Fig. 2).

Retarding the cooling rate of the mold minimized microshrinkage, reduced the ferrite content, and reshaped the ferrite into a globular and blocky form. Also, proper gating methods can reduce or eliminate microshrinkage.

Extensive testing showed that closer chemistry control will affect ferrite content, too. Since shotted material was found to have inadequate chemistry control for use in prime structural castings, the use of remelted bar stock was found to solve this problem.

Inhomogeneity existed in the cast structure — probably a segregation of copper on a submicroscopic scale. This made it necessary to homogenize the structure by heat treatment at 2100 F.

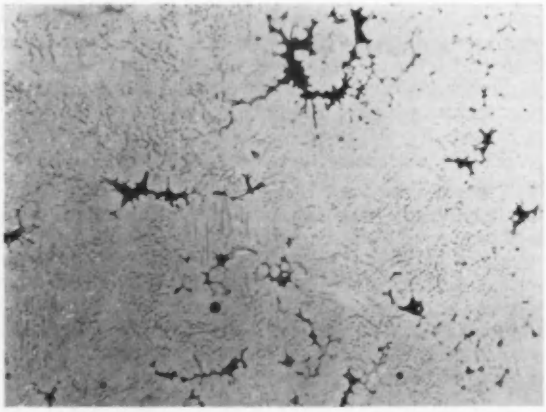

Fig. 1 — Microshrinkage in cast 17-4PH (reduced from microphotographs taken at 100 X).

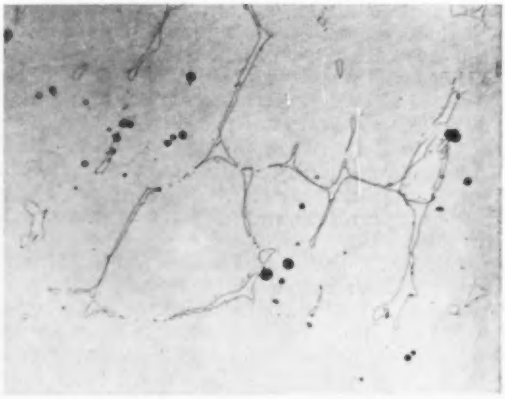

Fig. 2 — Dendritic delta ferrite in cast 17-4PH (reduced from microphotographs taken at 500 X). This was the most troublesome cause of low ductility.

Castings Are Strong

must be controlled closely to maintain ductility

Thus 17-4PH requires close chemistry control and precise foundry techniques. Prime structural castings of high standards and consistent quality necessitate constant control of foundry practices and heat treatment.

Hardness tests, X-rays, and chemical analysis cannot alone determine a casting's worth. Destructive testing of the casting is the only sure method — but, of course, is impractical. However good correlation exists between the properties of castings and integral bars (as shown in Fig. 3). So conventional testing methods are augmented by tests on two integral bars cast in each flask of critical investment castings. Correlation is established in the first three lots of castings, and a random 2% destructive inspection is conducted as a check.

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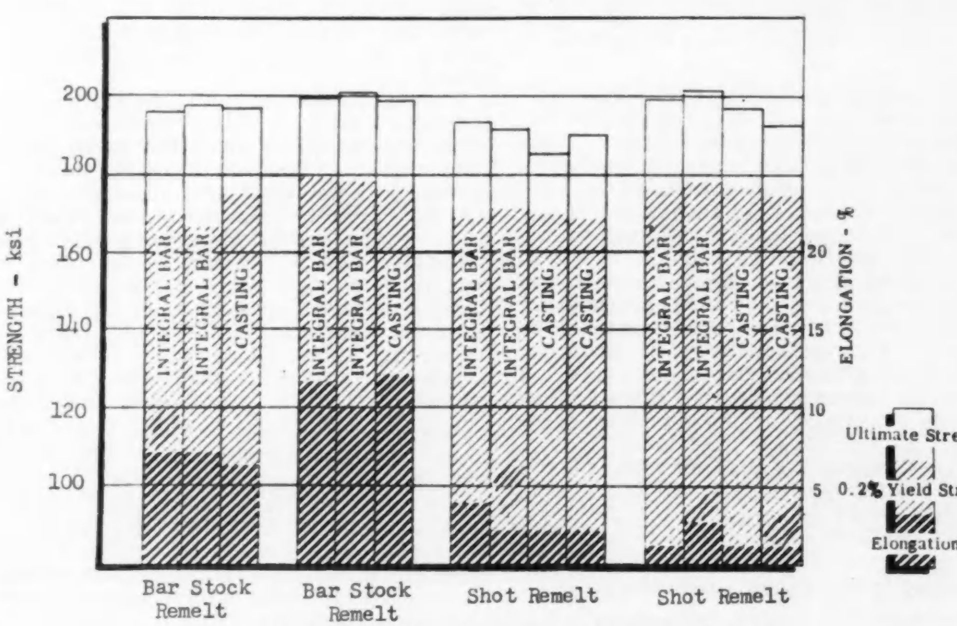

Fig. 3 — Correlation between properties of castings and integral bars.

Spark plug misfiring can be decreased

• during deposit buildup by a phosphorus additive and higher spark plug temperatures

• by improving fuel quality to eliminate knock

Based on paper by

H. P. Julien and R. G. Neblett

Products Research Division, Esso Research and Engineering Co.

STUDIES of spark plug misfiring due to lead fouling have shown that its severity can be decreased by converting the accumulating deposits to compounds having higher electrical resistance. One way this change can be accomplished is by adding a phosphorus compound to the deposit accumulation fuel. (The presence of lead oxide seems essential for this conversion.)

Deposits of high electrical resistance are also formed under conditions of high temperature operation. . . . However, prolonged operation at high temperatures isn't essential. Relatively brief exposures to high temperature are sufficient to effect at least a partial conversion, because the reactions leading to the conversion of low-temperature to high-temperature deposits are irreversible.

Spark plug temperature also determines the shunt resistance of the spark plug. High temperatures, as when knock occurs, increase misfiring. So fuel quality should be sufficient to prevent knock.

Lead compound formation on spark plugs

Compounds identified — The most common compounds identified in spark plug deposits occurring in passenger car operation are the lead halides and oxyhalides. These result from the tel and accompanying scavenger in conventional leaded fuels. Many complexes of lead oxide with the lead halides have been found. Fig. 1 lists some of the compounds and indicates their normal location on the ceramic.

When a phosphorous additive is incorporated in the fuel, a complex lead phosphate-lead halide — $3Pb_3(PO_4)_2 \cdot PbClBr$ — is formed on all parts of the plug. Possible chemical reactions leading to the formation of the lead halide-lead phosphate complex were investigated. It was found that the compound was not formed from lead halide alone. The oxide must also be present, either combined or as part of a mixture with the halide. Since lead metal is always produced from the halides, it is presumed that in a thin layer on a spark plug this can be oxidized to the necessary oxide-halide combination for further reaction with the phosphorus compound.

Compound formation is irreversible — Temperatures of formation of spark plug deposit compounds were obtained in a high temperature X-ray diffraction study. This study showed that the lead compounds identified at room temperature are the same compounds present on the spark plugs during high-temperature engine operation. No chemical changes take place when the deposits are cooled to room temperature. This is evidence for the irreversibility of the chemical reactions involved in formation of spark plug deposits.

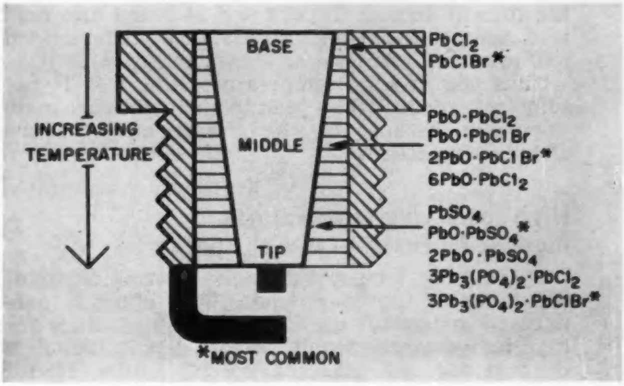

Fig. 1 — Compounds identified in spark plug deposits.

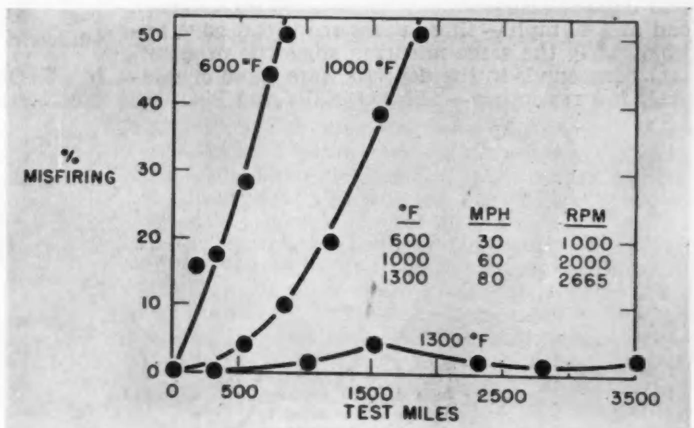

Fig. 2 — Misfiring decreases with increasing deposit-formation temperature.

Conduction temperature correlates with melting point — Lab tests showed that the electrical conductivity of lead compounds will increase as the compound melting point decreases. So melting point can be used to indicate misfiring tendency.

Changing deposit composition during deposit buildup

Two series of engine tests were made to study spark plug deposit formation at different temperatures. The first tests were at different average temperatures, and the second at a constant average temperature obtained in different ways. Deposits were accumulated with a commercial-type super-premium fuel containing no deposit modifier and a commercial 10W-30 oil.

Misfiring decreases with higher deposit-formation temperature — In the first series, deposits were formed at constant spark plug tip temperatures of 600, 1000, and 1300 F. At 600 F, only PbClBr was formed with the base fuel. Misfiring increased rapidly to 50% at 28 hr. The misfire pattern was nearly the same on the 1000 F deposit of 2PbO·PbClBr. Obviously, the shunt resistances of these two compounds fell below the minimum value required to prevent misfiring at the temperature (1500 F) of the rating. However, the $PbO \cdot PbSO_4$ formed at 1300 F gave only negligible misfiring, as shown in Fig. 2.

Throughout these tests, the differences in deposit composition were greater on the spark plug tip than on its base — reflecting the greater change in temperature at the point farthest from the coolant.

Phosphorus compound decreases misfiring — The effect of a phosphorus additive was investigated at 600 and 1000 F. When 0.2 theory of a phosphorus compound was added to the base fuel, misfiring was less at both 600 F and 1000 F than it was on the base fuel (Fig. 3).

Nevertheless, misfiring in the presence of deposits accumulated on phosphorus showed the same sensitivity to spark plug temperature that the base fuel did (see Fig. 3). There was more misfiring on the 600 F deposits than on the 1000 F deposits. . . . This

Spark plug misfiring

can be decreased

. . . continued

was due to less complete conversion of the lead halides to the innocuous phosphorus complex at the lower temperature.

Peak temperatures determine deposit formation — The importance of maximum spark plug temperature attained during formation of deposits was indicated by the second series of tests . . . run at 1000 F average spark plug tip temperature. This average temperature was achieved in four different ways (Fig. 4).

The amount of misfiring observed was consistent with deposit composition. Runs at 60 mph — road load and 40 mph — three times road load gave approximately the same misfiring since the predominant compounds in the deposits were those of relatively low resistance — $2PbO \cdot PbClBr$ and PbO. In the runs at advanced spark and at four times road load, compounds of higher resistance predominated and misfiring was less (as shown in Fig. 4).

Thus the average temperature measured is not sufficiently definitive — peak temperatures are more important because of the irreversibility of the chemical reactions.

High spark plug temperatures increase misfiring — as with knock

Spark plug temperature also determines shunt resistance of the spark plug. This effect is particularly important during accelerations, since the high temperatures which increase deposit electrical conductivity are attained quickly while deposit composition changes more slowly.

When knock occurs, spark plug temperature is increased. Under this condition more misfiring would be expected and has been found in a study on a 1958 model car. The misfiring increased in severity when the knock intensity increased. So care should be taken to ensure the fuel quality is sufficient to prevent knock.

To Order Paper No. 123T . . .
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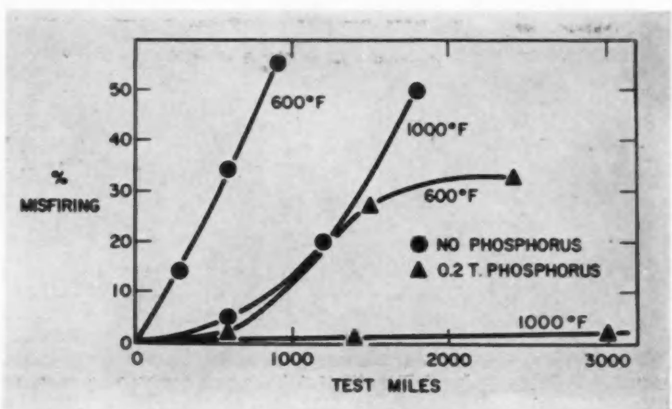


Fig. 3 — Phosphorus fuels decrease misfiring, but are still sensitive to spark plug temperature.

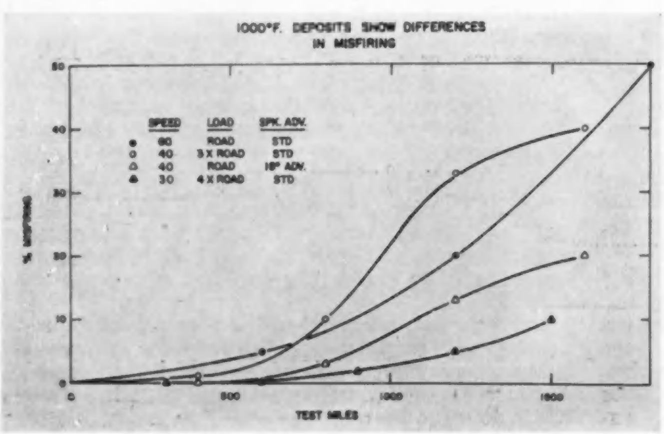


Fig. 4 — 1000 F deposits, attained in different ways, show differences in misfiring.

Space-age production methods are requiring

Maintenance-Trained Engineers

Based on secretary's report by

H. A. Sichler

Convair

DRAMATIC CHANGES in production methods in recent years dictate an entirely new concept of factory maintenance operations and personnel. Throughout the automotive industries, maintenance personnel must be trained to adapt itself to the new tools and techniques of this changing climate.

Increasingly, alert managements are taking broad initiative in providing adequate funds for re-training within their own organizations; for taking advantage of vendor training facilities where offered; and in working out the revised union agreements which often are necessary to keep re-trained employees at work in the maintenance area.

Boeing's activity in these areas is one good example of timely action to meet the new conditions whose arrival became apparent as soon as numerical control systems were introduced.

First step at Boeing was to assemble a maintenance group comprised of electrical and electronics engineers, heating and ventilating engineers, mechanical engineers, and construction engineers. This group was set up to assist the factory executives in charge of maintenance supervision. It was particularly helpful in establishing the necessary training programs.

Next, Job Standard Descriptions were revised . . . to include required skills and upgraded pay scales. Otherwise, the maintenance personnel would have been lost to higher paying jobs elsewhere.

After revising the Job Standard Specifications, Boeing sent selected employees and supervisors to vendors plants to learn how to operate and maintain the systems being obtained from the particular vendors. Then this group came back to Boeing, helped set up more training programs, and imparted their knowledge to others.

Boeing experience showed quickly the value of training personnel in basic electronic and hydraulic fundamentals. From such trainees, a manpower pool was developed from which personnel is selected for further specialized training.

The Boeing training program costs about $1000 per man, exclusive of the cost of replacing him while he is in training. The cost is believed justifiable in view of the increasing demand for specialists — and the future promise of more and more complex machines.

As the expense of facilities keeps going up throughout the automotive industries, preventive maintenance becomes ever more important. "Down time" for maintenance and repair becomes economically intolerable. Only skilled maintenance personnel and prudent planning can prevent costly breakdowns.

Some companies have had difficulty in getting unions to agree to the necessary changes in classifications, especially where electrical workers have been involved. There have been cases where the company has trained electrical maintenance personnel and found union opposition to their upgrading. . . . But these problems, in general, seem to be on their way to being worked out to long-term satisfaction.

Practically all manufacturers are agreed on the desirability of using vendor training facilities where and when they are available. In many cases, prime contractors take the initiative in sending maintenance men to vendors for training — especially when dealing with a product for the first time. Nor is it uncommon for manufacturers to send professional or supervisory personnel to work closely with vendors in establishment of training programs. Sometimes manufacturers are found relying entirely on vendor training as regards special products and systems.

To Order SP-329 . . .
. . . on which this article is based, turn to page 6.

Serving on the panel which developed the information in this article, in addition to the panel secretary, were **L. Garrison,** Boeing Aerospace Division; **W. O. Lindstrand,** Norair Division, Northrop Corp.; **H. A. Smith,** Convair; **D. C. Freeburg,** North American Aviation, Inc. (co-chairman); and **D. B. Acker,** Convair (chairman).

CFR Coker Rates Jet Fuel Thermal Stability

Lab test results show correlation

Based on paper by

J. D. Rogers, Jr.

E. I. du Pont de Nemours & Co., Inc.

FUEL THERMAL STABILITY at jet operating temperatures can be determined by laboratory methods developed by the Coordinating Research Council. The CFR fuel coker technique determines the threshold temperatures at which deposit-forming reactions occur in fuels. For a fixed time and temperature, the test is inherently a pass-fail criterion. Stable fuels can be distinguished with a high degree of confidence . . . in this regard, the test is most effective as a fail-safe device for screening fuels.

Direct correlation between these laboratory ratings and full-scale engine performance has been established by flight test data and an analysis of engine operation under service conditions.

IN ADDITION to acting as chairman of the CRC Turbine Fuel Thermal Stability Group, **John Rogers** is also active in CRC fuel research groups on flame radiation, electrical discharges and ice formation. He is a member of the Advisory Board to ASTM Technical Committee J on Aviation Fuels, and is also active in SAE, American Rocket Society, and the Institute of Aeronautical Sciences.

He is supervisor of the Aviation Development Group at the du Pont Petroleum Laboratory. Before joining du Pont in 1951, he worked for 6 yr as a research engineer for Standard Oil of California. During World War II he was a design engineer on B-29 powerplants.

A research coker similar to the CFR fuel coker has been designed to operate at temperatures above 500 F for short periods. Still under test, the equipment will evaluate hydrocarbon fuels for Mach 3 (and higher speed) aircraft.

Standard CFR fuel coker

Fig. 1 shows the equipment for measuring high-temperature stability. Liquid fuel is pumped through an electrically-heated preheater section. Laminar flow is maintained at low Reynolds number in the annular space between the inner and outer tube. The fuel then passes into a heated filter section where fuel degradation products may become trapped. The stainless steel filter is a sintered matrix with average pore size of 20 microns. Fuel flow rate is held constant.

A 1/16-in. diameter thermocouple placed in the centerline of the preheater outlet measures the fluid temperature. The filter unit has a cast-in heater and a thermocouple which measures metal-wall temperature.

The increased pressure differential (and $/\overline{\Delta P}$) at the test filter indicates the deposits being collected. This measurement is used in combination with the deposit condition on the surface of the preheater inner tube to assess the thermal stability of the fuel.

Preheater deposits are rated visually, after the tube is dried with a stream of pentane or hexane. The tube surface area is examined under a controlled light source at each inch along the tube. The deposit colors are matched against color strip standards and reported by the code shown in Table 1. Darkest deposits are reported, rather than the average. Small individual spots less than 0.05 sq in. are ignored, provided there are no more than three on the entire tube.

Experiments with threshold temperature techniques

Experiments were conducted on 10 fuels prepared by conventional refining processes, used in combi-

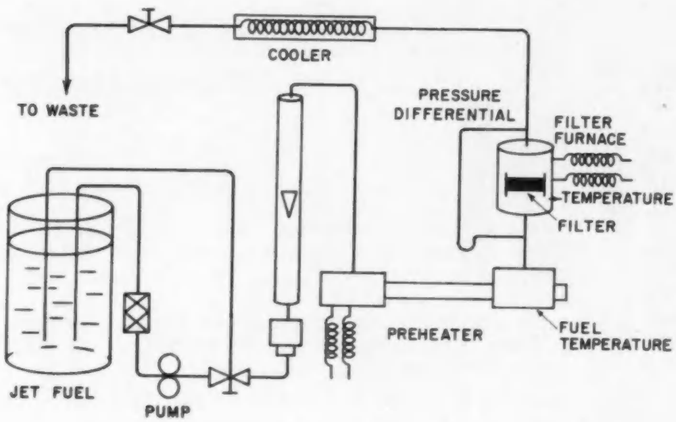


Fig. 1 — Schematic of CFR fuel coker.

with flight performance

nation with additives to provide a range of thermal stabilities.

Military MIL-J-5624 fuel specifications were followed as closely as possible in defining the JP-4, JP-4 referee, and JP-5 types of test fuels. A specially-treated kerosene of good stability was also included. Most of the fuels contained conventional antioxidant and corrosion inhibitors.

A range of temperatures was used to determine the temperature at which either filter plugging or preheater deposits occurred. Each test was conducted for 5 hr at preheater temperatures varying in increments of 25 F, from 275 F to 450 F. In most cases, filter temperature was 100 F higher than the preheater temperature.

Fuel instability was indicated arbitrarily by a pass-fail point of No. 3 (see Table 1) or higher for preheater deposits, and a pressure differential of 13 in. of mercury or higher for filterability. Instability increased as the temperature increased until a threshold was reached. Some of the fuels broke sharply, and the shape of the individual curves resembles an oxidation induction period.

The threshold temperatures determined for the test fuels are shown in Fig. 2. The majority of these test fuels seem to be limited in the 300–450 F range by tube deposits rather than filterability. Precision of threshold temperature determinations is about ± 31 F.

Correlation with full-scale engine results

Air Force Flight Tests — The Air Force conducted 100-hr flight tests on five JP-4 fuels having different thermal stabilities as measured by the CFR fuel coker. CFR coker stability ratings were obtained by Wright Air Development Center at periodic intervals during each flight test; data were also obtained by the CRC Exchange Panel. Fig. 3 shows the WADC ratings.

Threshold temperatures determined by WADC are

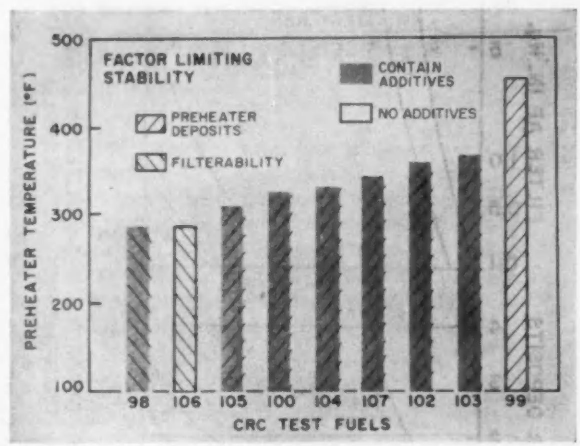
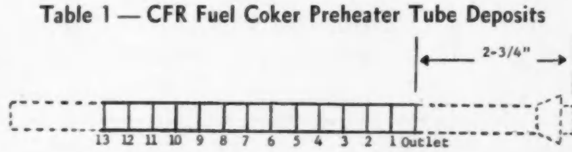


Fig. 2 — Stability threshold temperatures of fuels tested in the CFR fuel coker.

Table 1 — CFR Fuel Coker Preheater Tube Deposits



Deposit Rating Code (Use with CRC-ASTM Color Standards):
- 0 — No visible deposits
- 1 — Visible haze or dulling, but no visible color
- 2 — Barely visible discoloration
- 3 — Light tan
- 4 — Heavier than Code 3

Table 2 — High-Temperature CFR Research Coker Operating Conditions

1. Preheater and Filter Temperatures	to 750 F
2. Fuel Flow Rate	2–8 lb/hr
3. Fuel Pressure	100–250 psig
4. Fuel Specific Gravity Range	0.7–1.2
5. Reservoir Temperature	Ambient–250 F

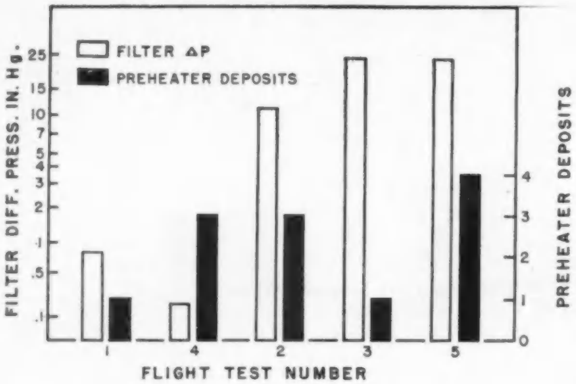


Fig. 3 — Average CFR fuel coker ratings of flight test fuels.

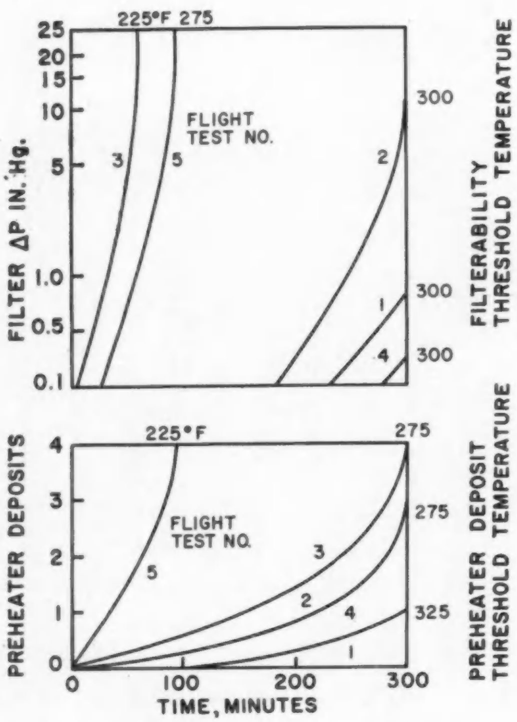


Fig. 4 — Threshold temperatures of flight test fuels.

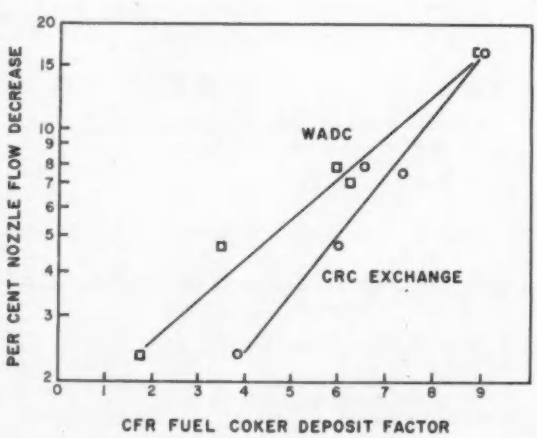


Fig. 5 — Coker results related to flight tests.

CFR Coker Rates Jet Fuel Thermal Stability

. . . continued

shown on the top and side of the charts in Fig. 4. These temperatures show that preheater deposits and filter deposits are both important in terms of engine performance.

By combining the preheater tube deposits rating and the filter rating, a deposit factor for the CFR fuel coker is obtained:

$$\text{Deposit factor} = \text{Preheater Deposit Rating} + \sqrt{\text{Filter}\Delta P}$$

Fuel system cleanliness after each flight test (made with an F-100 plane powered by a J-57-21 engine) was determined by nozzle deposits and flow calibrations, and expressed as the per cent decrease in engine fuel flow.

There is a distinct relation between the flight test data and the CFR fuel coker deposit factor, as shown in Fig. 5. The WADC data are somewhat milder on the average than the CRC data, as the latter were often obtained some time after the flight tests. Fig. 6 shows that per cent decrease in fuel flow with each fuel shows good correlation with its stability in the CFR fuel coker.

Correlation with service experience

Serious difficulties in B-52 jets operated by the Strategic Air Command were caused by the same JP-4 fuel used in the fifth of the flight tests mentioned above. This fuel was unstable at 300 F preheater and 400 F filter temperatures in the CFR fuel coker.

Also, the performance of JP-5 fuel thermally stable at 300 F preheater and 500 F filter temperatures has been satisfactory in Navy service with no deposition difficulties in the engine fuel systems.

High-temperature research fuel coker

The high-temperature research coker designed by the Equipment and Procedure Panel of the CRC Thermal Stability Group is still under test. It may be changed as the result of continued development with three prototype models.

A schematic flow diagram of the coker is shown in Fig. 7. Fuel is exposed to long heat transfer periods in a stainless-steel 10-gal reservoir at temperature-time conditions similar to those in airframe wing tanks.

A comparison of preheater section dimensions for the CFR fuel coker and the research coker is shown in Fig. 8. The flow area and heat flux in the research coker are higher. The tube length and annular fuel space between the inner and outer tubes are essentially the same, to provide equivalent Reynolds number. The research unit is capable of operating at the conditions summarized in Table 2.

To Order Paper No. 103T . . .
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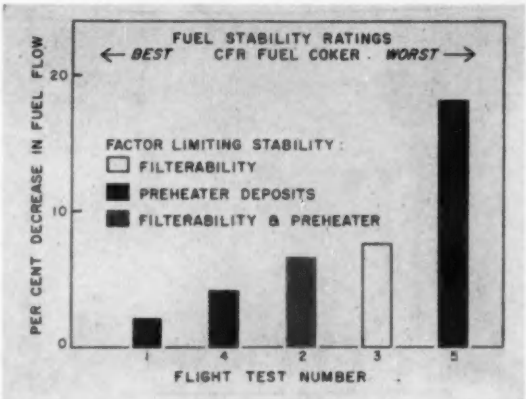

Fig. 6 — Decrease in fuel flow correlated with CFR fuel coker ratings.

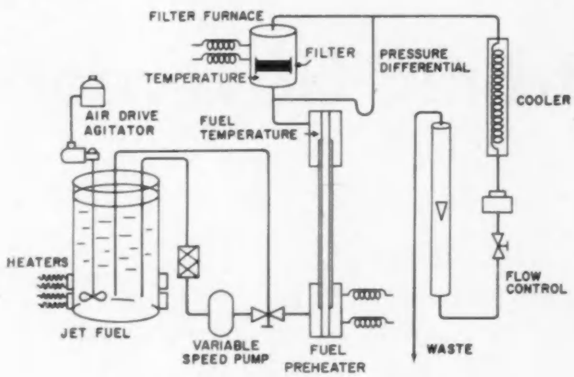

Fig. 7 — Schematic of CFR research fuel coker.

ONE OF THE responsibilities of the Coordinating Research Council is to develop valid lab procedures for evaluating effects of high temperatures on jet fuel stability. Mr. Rogers' paper is a report of the CRC Fuel Thermal Stability Group.

SAE and the American Petroleum Institute have sponsored CRC programs on fuel rating techniques. These have been conducted in close liaison with the Navy Bureau of Aeronautics and Wright Air Development Center.

The CFR fuel coker technique for evaluating the thermal stability of aviation turbine fuels was accepted by the American Society for Testing Materials as a tentative standard at the annual meeting in June 1959 and is now under the jurisdiction of Committee D-2 on Petroleum Products.

Until reference fuels are developed for calibrating the CFR fuel coker, fuel samples are exchanged periodically under an Exchange Panel. This provides equipment standardization data on a variety of fuels. Agreement among participating laboratories in rating stable and unstable fuels at temperatures used by the Military for JP-4, JP-5, and JP-6 has been satisfactory.

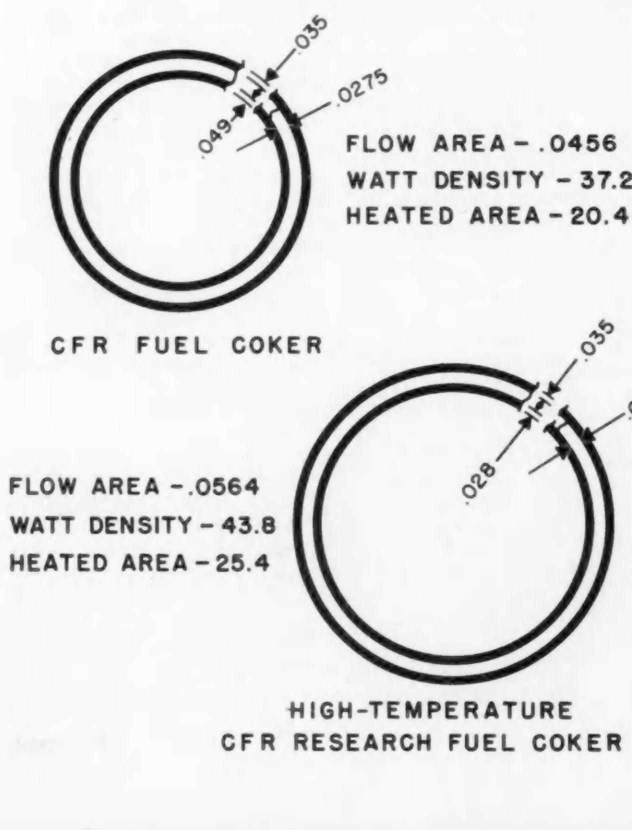

Fig. 8 — Comparison of CFR fuel coker and research coker preheaters.

Engine Control in 0.006 Sec Claimed for Electronic Governor

Based on paper by

J. E. Frederick
Westinghouse Electric Corp.

A HIGH-FREQUENCY magnetic amplifier is the key to engine control in 0.006 sec in the Westinghouse model EFG governor. By using a 1200-cps power supply, the response time of the magnetic amplifier is reduced to 0.001 sec, making the overall 0.006 time to start of engine control possible.

The time schedule for the whole operation adds up to — 0.001–0.002 sec for the frequency sensing circuit to produce an output signal when engine to be governed is off speed, 0.001 sec for a magnetic amplifier to respond to the error signal, and 0.003 sec for a hydraulic actuator to start throttle movement after it receives the amplified error signal. After that, it is up to the speed of response of the engine.

The stepped-up amplified performance hinged on the development of a high-frequency transistor inverter. The inverter takes the 12-v d-c power usually available on an engine and converts it to the 1200-cps a-c current, which gives the fast magnetic amplified response. Normally, only 60-cps or, at best, 400-cps current is available from outside sources. Teaming the inverter and amplifier produces a small, rugged package, mainly because there are no electronic tubes.

The operation of the whole system is shown in the block diagram. (See pp. 65). The first step is the speed sensing, shown at the top of the block diagram. Single-phase a-c current is taken from the generator of a motor-generator. If a mechanical load is on the engine, a small permanent magnet generator must be added to the engine output. The output of the generator is isolated by a transformer and fed to a tuned LC circuit, which converts the generator frequency to a proportional a-c voltage. Finally, the a-c voltage is rectified and the d-c output of the frequency measuring circuit is compared to a standard or reference d-c voltage. Any difference in voltage produces an error signal for the magnetic amplifier.

The amplifier supplies a push-pull signal to an electrically controlled servo valve. This ports hydraulic fluid to a piston, which is the actuator for the engine throttle. The high-pressure hydraulic fluid is supplied by an engine pump.

The rest of the circuit supplies negative feedback for stability and adjustment for load-sharing when more than one motor-generator is paralleled in an isochronous mode. The feedback signal is differentiated to produce a velocity rather than position signal for the throttle. The signal is zero when the throttle reaches its new position. This type of feedback can be modified or eliminated when operating with droop by setting the potentiometer, R-17, to a lower resistance.

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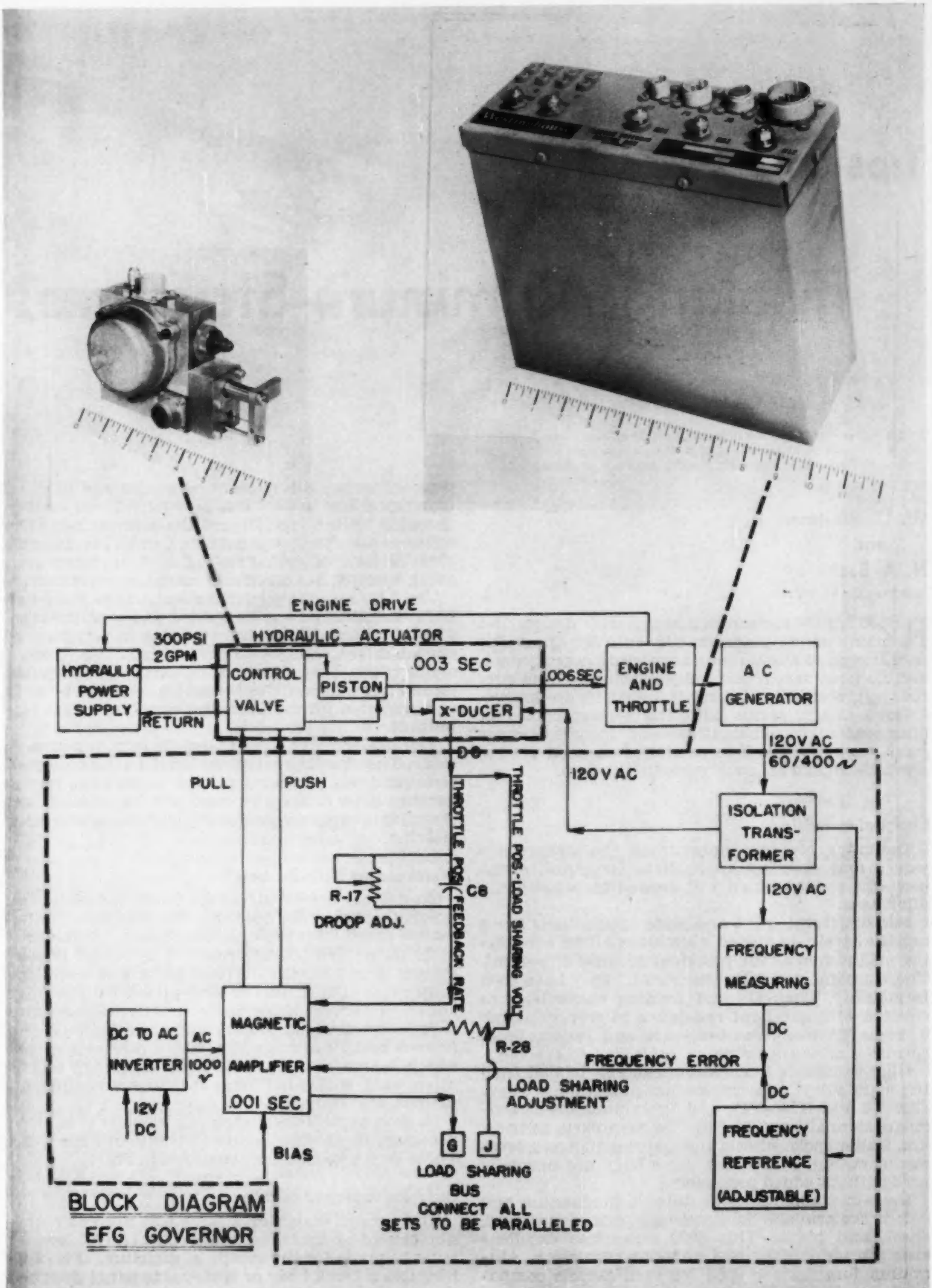
ENGINE DRIVE
300PSI
2GPM
HYDRAULIC ACTUATOR
HYDRAULIC
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THROTTLE
A C
GENERATOR
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60/400 ~
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120V AC
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TRANS-
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R-17
C8
DROOP ADJ.
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FREQUENCY
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FREQUENCY ERROR
DC
LOAD SHARING
ADJUSTMENT
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LOAD SHARING
BUS
CONNECT ALL
SETS TO BE PARALLELED
FREQUENCY
REFERENCE
(ADJUSTABLE)
BLOCK DIAGRAM
EFG GOVERNOR

Tips on

Making Aluminum Structures

Based on paper by

W. C. Weltman, Jr.
and
N. A. Bast
Aluminum Co. of America

RESISTANCE to corrosion begins with design. No maintenance program will entirely offset the poor design of aluminum transportation equipment, and no good design will fail prematurely from corrosion, provided conditions of operation are known.

Good design begins with the correct choice of alloy and alloy combinations and includes proper joint geometry. And to capitalize on good design, a vehicle should be given periodic checkup.

Choice of materials

Designing requires determining the stresses involved and choosing appropriate structural members, the size of which will depend in part on the alloy used.

For structural sheet and plate applications there are the strain-hardened aluminum alloys containing magnesium as the principal alloying ingredient. These are known as the 5000 series. They have good formability, strength, and welding characteristics coupled with excellent resistance to corrosion and, in some grades, great brilliance and resistance to corrosion after anodizing.

High resistance to corrosion can also be had from the cast alloys, the aluminum-magnesium alloys (220-T4 and X250-T4), and the aluminum-silicon-magnesium alloys (356-T6). In such parts as truck and trailer spoke wheels, hubs, spring hangers, cross members, and suspension parts they are normally used without added protection.

Heat-treatable alloys containing magnesium and silicon are available in structurals, extruded shapes, sheet, and plate. This 6000 series has excellent strength, weldability, and corrosion resistance. Aluminum forgings are used for such chassis components as disc wheels, hubs, door hinges, and suspension parts. Alloys commonly used are 6151-T6 (corresponding to SAE 280-T6) and 6061-T6 (corresponding to SAE 281-T6) and the aluminum-copper series — 2014-T6 (corresponding to SAE 260-T6) and 2024-T6 (corresponding to SAE 24-T6). They have great strength in addition to corrosion resistance.

The 2000 series is very important. This group has high strength and can be welded under proper conditions. These alloys are available in forgings, in extruded form, and as sheet and plate. For normal highway use, they should be painted. Forgings designed from these alloys should be devoid of pockets and provision for drainage and easy cleaning is important.

The 2000 series in sheet and plate form is normally clad. The cladding sacrifices itself to the core material and will protect it for the normal life of the vehicle. The 6000 series need not be cladded, but cladding improves appearance, brightness, and color match.

Watch out for dissimilar metals

To prevent corrosion, isolate dissimilar metals or prevent water from entering the interface. Bitumastic compounds are effective sealers. Zinc-chromate pigmented primers followed by a coat of aluminum paint on the ferrous parts give excellent protection. Cadmium- or zinc-plated fittings offer added protection since these metals will sacrifice themselves slowly to protect both the aluminum and ferrous part. Stainless steel has a passivating film which makes it compatible with aluminum and is often used with aluminum in process equipment, fittings, and fasteners.

In such applications as spring hangers it is often necessary to provide inserts at points of high wear. Three such applications are shown in Fig. 1.

Designing to prevent corrosion

The correct design of a joint will prevent corrosion caused by dissimilar metal contact. Allowances must be made for the escape of moisture. Fig. 2 illustrates a truck body or trailer side panel designed to prevent entrapment of moisture. There are no

Corrosion—Free

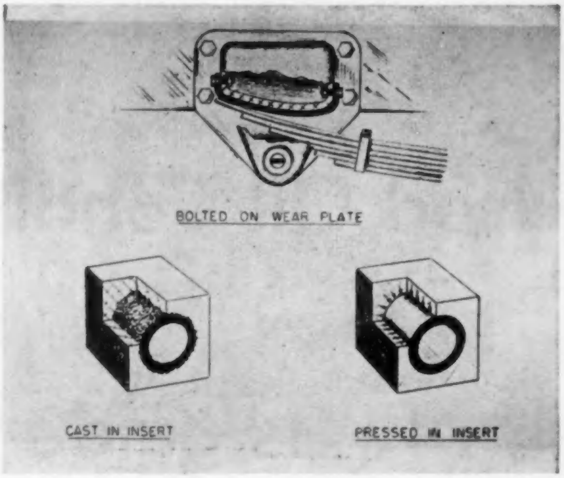


Fig. 1 — Three examples of using inserts at points of high wear in spring hangers. The mass of aluminum is large in relation to the steel insert, and being anodic to the steel, protects the insert with very little, if any, effect on the aluminum.

traps on the outside surface and the side sheet to extruded side sill joint has ample opportunity to drain and dry out should moisture enter. There is no moisture trap between the extrusion and the cross member. Similar joints are required between cast or wrought aluminum cross members and fittings and aluminum or steel frame rails.

Use of identical joint geometry for a smooth skin design is shown in Fig. 3. Drain holes should be supplied on the horizontal surface of the extrusion because foreign material can collect and hold moisture. The interior lining, however, can be lapped over the extrusion to reduce the possibility to a minimum, whether the van is for dry freight or refrigerated cargo.

Design for easy cleaning. Crevices from sloppy lap or butt joints are very undesirable. Narrow grooves and acute angles are next to impossible to clean mechanically and may even be missed in steam cleaning. Fig. 3 shows an additional flooring extrusion for a refrigerated van which takes these principles into consideration and applies them.

Poultice action also causes corrosion. Moist dirt or other material, which may or may not be corrosive to aluminum or steel, is permitted to remain in contact with the metal surface. Oxygen is screened from the surface at the interface and the metal has no chance to protect itself by the formation of inert oxides. Corrosion then appears as an attack of pitting which might penetrate the metal at that point alone. At the minimum it makes the metal unsightly by staining or etching.

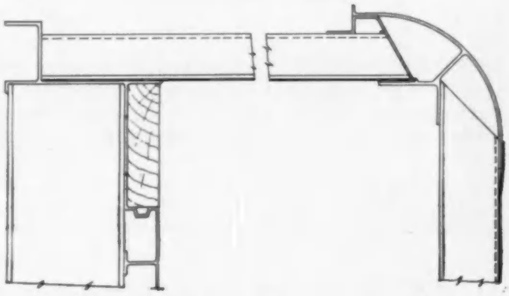


Fig. 2 — Example of a truck body or trailer side panel designed to avoid all pockets where moisture could be trapped to launch the process of corrosion.

Varieties of protective films

Newly cleaned surfaces can be protected by transportation waxes for six months to a year. Some of them are sprayed on. A more lasting protection is given by spraying on two wet coats of lacquer. If the cleaning process is thorough and the lacquer coat is not disturbed mechanically, the protection endures for many years.

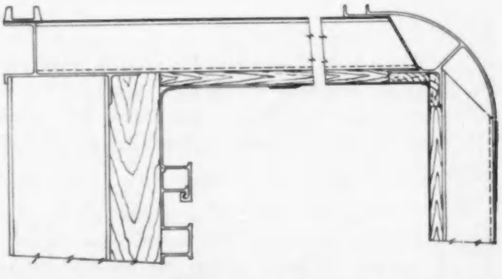


Fig. 3 — Refrigerated van with additional floor extrusion. There is no place where dirt and filth can collect and corners can be swept out or steam cleaned. The inside corner radius makes for strength as well as for ease of cleaning.

To Order Paper No. 115U . . .
. . . on which this article is based, turn to page 6.

Used Oil Condition . . .

. . . is guide to oil evaluation

Based on paper by

O. L. Spilman and W. F. Ford

Continental Oil Co.

USED OIL condition, measured by routine analytical tests, can provide certain correlations with performance which can improve dependability of motor oil evaluations for low-duty, high-output engines. This conclusion arises from recent tests undertaken because:

a. Low-duty operating conditions are conducive to oxidation and polymerization of fuel blowby products, with little oxidation of the oil.
b. The low-temperature oxidation mechanism does not appear to lend itself as readily to accelerated test conditions as does its high-temperature counterpart.

Six taxicabs and a small fleet of retail milk delivery trucks were used to obtain field service data for these studies, which provided quite helpful relationships and correlations between the used oil condition and the performance of the engines of these vehicles.

EVER LONGER lab tests are being required to determine motor oil quality for current high-output engines that run a significant part of the time under a low power factor, and at low to moderate temperatures.

The low-temperature oxidation mechanism doesn't lend itself to accelerated test conditions as does its high-temperature counterpart.

This article gives a possible answer to the problems of increased information per test and improved dependability of test results for oil performance in low-duty, high-output powerplants.

"The relationship between used oil insolubles and sludge deposits," the authors say, "provides a useful tool for defining the low-temperature characteristics of motor oils."

Oxidation patterns

Initial correlation of the used oil condition and engine performance was based on used oil analyses from the two types of engine operating conditions shown in Table 1. The conditions represented a wide range in temperature. The high-temperature tests are steady-state operation. Although the low-temperature test conditions are cyclic, the temperature, speed, and load are quite low in each phase of the cycle.

The high-temperature tests were run in small, 4-cyl, 2⅝-in. by 2¾-in. engines. A 371 cu in., V-8 engine was used for the low-temperature work.

The used oil analytical methods employed are:

	ASTM Method
Acid Number	D 664-58
Pentane Insolubles	D 893-52T
Benzene Insolubles	D 893-52T
Insoluble Resins	D 893-52T
Soluble Resins	(See Appendix I of the complete paper)

in low-duty, high-output engines

All of these methods are familiar, with the possible exception of the soluble resins method. This is a chromatographic separation with Attapulgus clay, which removes all the oil soluble oxidation products plus the insoluble oxidation products. The soluble resins value is obtained by subtracting the pentane insolubles from this total.

Preliminary study of used oil analyses indicated a different relationship between acid number and soluble resins for the high-temperature, corrosion-type engine test and for the deposit-type tests. The type of oxidation, corrosive or deposit, appeared to be a function of the acidity of the oil soluble resins.

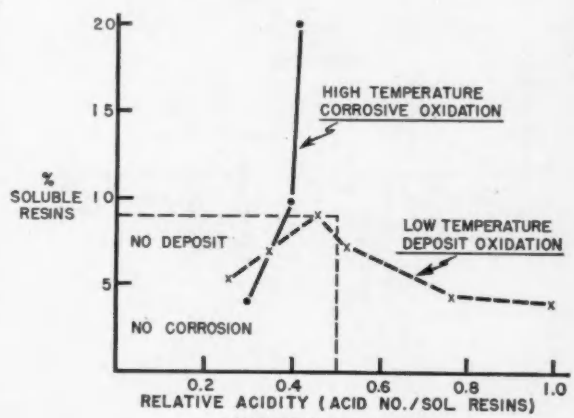
This led to development of the relationship between soluble resins and "relative acidity" as an indication of different types of oxidation. (The term "relative acidity" is the ratio of acid number to the per cent oil soluble resins and relates the total acidity to the oil soluble oxidation products.)

This relationship (shown in Fig. 1) illustrates the ability of this type of plot to differentiate oxidation type. High-temperature oxidation is identified by high-soluble resins, low relative acidity. Low-temperature oxidation is associated with low-soluble resins and high relative acidity.

The boxed areas outlined by the dotted line in Fig. 1 may be described as defining how good an oil is, or its effective life. The area outside the box defines how bad an oil is.

The length of time for which a motor oil will maintain the condition defined by the boxed area under a given type of operation is a very definite measure of the oil quality. The oil condition defined by this boxed area is relatively insensitive to normal variations in operating temperatures and contaminants encountered in field service and will maintain a clean engine. The farther the oil condition departs from this area the more sensitive it becomes to small variations in operating conditions.

This plot is the basis for the various relationships developed. Use of the high-temperature oxidation



OXIDATION PATTERN

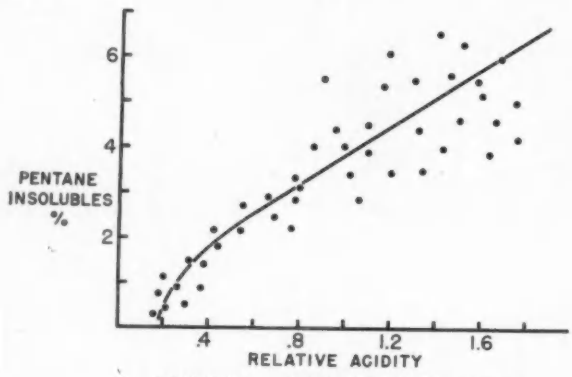
Fig. 1

Table 1 — Test Operating Conditions

	Test Time, hr	Engine Speed, rpm	Load, bhp	Oil Temperature, F	Water Temperature, F	Air/Fuel Ratio
High Temperature	72	2500	5	280	200	14.0/1.0
Low Temperature	2	600	0	130	95	10.0/1.0
	2	1000	8.2	130	95	....
	2	1600	10.0	145	95	16.0/1.0
	64 Cycles — 384 Hr					

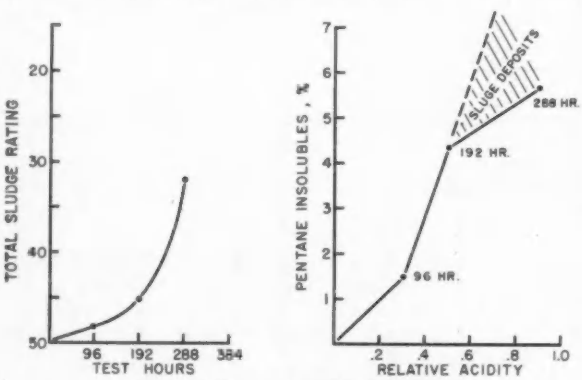
Used Oil Condition

... continued



ACIDITY vs INSOLUBLES RELATION
LOW DUTY SLUDGE TEST
371 cu. in. V-8 ENGINE

Fig. 2



DEPOSITS vs OIL INSOLUBLES
LOW DUTY SLUDGE TEST
S-1 QUALITY 10 W-30 OIL

Fig. 3

pattern permits us to predict, with reasonable accuracy, the start of copper-lead bearing corrosion and the degree in L-4-type laboratory tests.

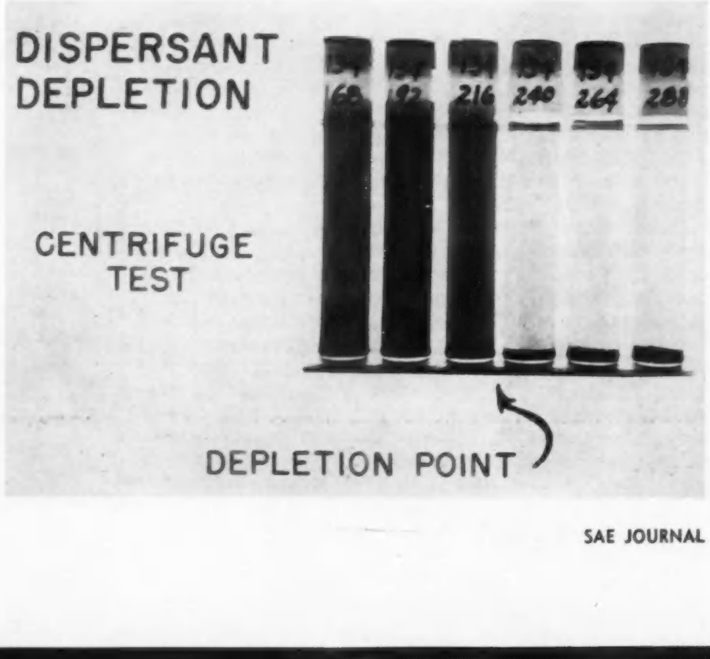
The deposit oxidation curve permits prediction of the start of significant insolubles formation. It also provides a good estimate of the quantity and type of insoluble material being formed. This, in turn, may be related to the quantity and type of deposit being formed.

In general, as the relative acidity increases the quantity of used oil insolubles increases. This is shown by the plot in Fig. 2. These data were obtained in the low-duty sludge test with a variety of additive types and concentrations. This in part explains the scatter of the data, as additive type will have some effect on this relationship. The major cause of the scatter, however, is "dispersant depletion."

This is illustrated by the data in Fig. 3. The left-hand curve shows intermediate sludge deposit ratings made during a low-duty sludge test. A rather low rate of sludge formation is shown for the first 192 hr, but a much higher rate is shown for the last 96 hr of test. The right-hand curve is a plot of relative acidity versus pentane insolubles in the crankcase oil. This shows a rather low rate of insolubles formation during the first 96 hr. A rapid increase in rate occurs between 96 and 192 hr but is effectively dispersed, as indicated by the continued low rate of sludge formation for that period of the test.

Sometime after 192 hr, however, highly acidic sludge precipitants are formed, as indicated by the increasing relative acidity; and effective dispersancy is lost. This is shown by the break in the insolubles curve and is the result of an increased percentage of the insolubles being precipitated as deposits. These sludge deposits necessarily reduce the pentane insolubles retained in the used oil and, as a result, af-

Fig. 4



fect the pentane insoluble-relative acidity relationship.

The loss of effective dispersancy is also shown by the photograph in Fig. 4. These are samples of test oil taken from the engine test shown in Fig. 3 and run in the centrifuge sludge dispersancy test. This test requires only 2 cc of the used oil, which is diluted with 13 cc of normal hexane and then centrifuged. These samples show that effective dispersancy was completely lost between 216 and 240 hr.

This relationship between used oil insolubles and sludge deposits provides a useful tool for defining the low-temperature performance characteristics of motor oils. This is illustrated by the data in Figs. 5 and 6.

Fig. 5 shows the sludge deposition rate in our low-duty sludge test of four high-quality oils representing three dispersant types. Results of two tests on oil A are given to provide a measure of the significance of the differences shown between oils. All four oils have CRC L-4 corrosion induction periods of 72 hr plus and pass sequences 1, 2, and 3 of the AMA MS Test. All, with the exception of oil D, pass the Caterpillar L-1 test using 1.0% sulfur in the fuel.

Comparison of these oils, on the basis of deposits only, would certainly permit us to select the best additive combination for this particular operation. It provides little indication, however, of why the differences exist or how the different additive types and combinations function. This information is important to those concerned with the development of new oil formulations, as it permits more intelligent selection and balancing of additive combinations.

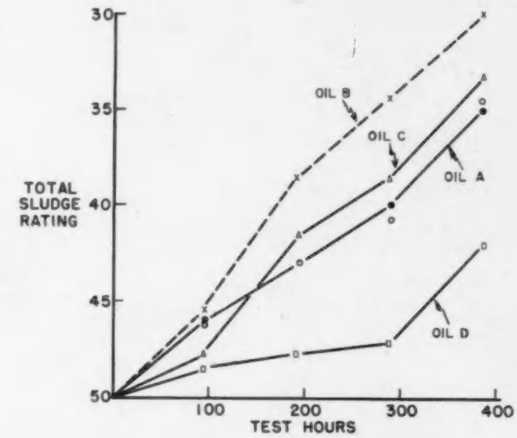
Introducing the used oil condition, as indicated by pentane insolubles, into the comparison permits a somewhat broader and more significant evaluation of the performance characteristics of these oils. Previous investigators have shown rather conclusively that engine deposits are controlled by the mechanisms of inhibition, dispersancy, and solubilization. The data in Fig. 6 illustrate how inhibition and dispersancy characteristics may be defined by the relation between sludge deposits and insolubles. Normally, we use only the final or lower right-hand plot. As this is rather complex, we have included successive plots for each of the inspection and sample periods of the engine test.

The plot of used oil insolubles versus total sludge deposits indicates the degree and distribution of the total sludge components formed. The lighter the sludge deposits for a given insoluble level the better the dispersancy. It has been our experience, also, that oils of a given quality range will closely follow a common dispersancy line during their effective life and depart from this line only when dispersancy depletion occurs, as shown in Fig. 5. The results of two tests of oil A are shown to illustrate the significance of the differences shown between oils.

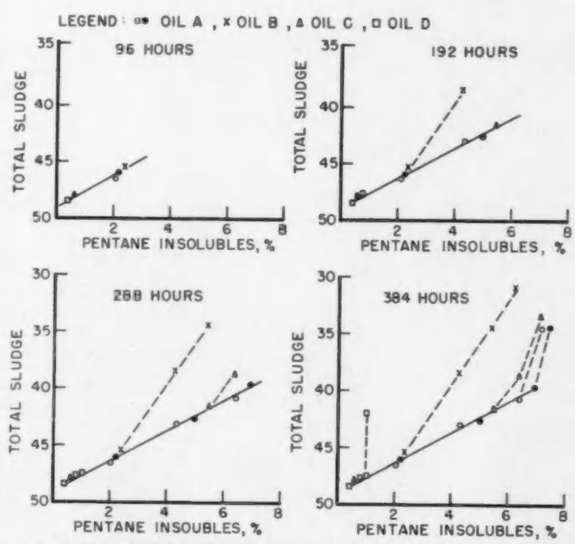
Now let us see what can be learned from a plot of this type. At 96 hr, oils C and D show lighter deposits and lower insolubles than oils A and B, indicating they possess better low-temperature oxidation inhibition. All of the oils appear to lie along a common dispersancy line, but insolubles formation is still too low to judge dispersancy accurately.

At 192 hr, oil D still shows very light deposits and low insolubles, indicating continued effective inhibition. Oil C, however, has passed its initial induction period; and significant insolubles formation has occurred. It still retains effective dispersancy, as it still lies on the common dispersancy line. Oil B, which lost its effective inhibition prior to 96 hr, has now also lost effective dispersancy, as it has departed from the common dispersancy line and is showing heavier deposits. Normally, this test would be terminated at this point, permitting a significant saving in test time. Oil A, which also passed its initial induction period prior to 96 hr, still retains effective dispersancy, with deposits forming at a rather uniform low rate.

At 288 hr, oil D still retains effective inhibition



SLUDGE DEPOSITION RATE
LOW DUTY SLUDGE TEST
Fig. 5



SLUDGE DEPOSITS vs USED OIL INSOLUBLES
Fig. 6

and shows light deposits. Oil C has lost effective dispersancy, while oil A still follows the common dispersancy line.

At 384 hr, all of the oils have reached what we term "total depletion," as indicated by their departure from the common dispersancy line. Oil D has formed significant deposits at a low insolubles level, indicating that this additive combination functions primarily as an inhibitor and has relatively poor dispersant properties. The relatively low level of sludge deposits with this additive as compared with the other oils, however, indicates that inhibition is a more effective means of controlling sludge deposits than dispersancy. Oil B is shown to have poorer inhibition and dispersancy than oils A and C.

We have indicated the effects of inhibition and dispersancy. It was previously stated, however, that a third mechanism is involved in sludge control, solubilization of deposits. Our experience indicates that this is probably the least effective method and also the most difficult to measure. It appears that the solubilizing ability of motor oils is quite small relative to the total sludge material that must be handled so that this effect on sludge deposition is minor.

Table 2 — Relative Comparison of Additive Characteristics

	Inhibition	Dispersancy	Solubilization
Oil A	3	1	3
Oil B	4	3	4
Oil C	2	2	2
Oil D	1	4	1

It is believed that the centrifuge sludge dispersancy test also provides some measure of this solubilizing effect. This is illustrated by Fig. 7, which shows the centrifuge test samples. This photograph illustrates three significant gradations in appearance: The very dark sample indicates dispersed material; the somewhat lighter sample shows no dispersed material but is darkened by soluble oxidation products; and, finally, the essentially clear sample denotes total depletion. Unfortunately, black and white photographs do not show the true differences between samples. This one is shown only to indicate that differences do exist. We are currently working on a color rating system which will reflect this characteristic.

Some oils will "break" directly from the very dark sample to the clear sample. These oils show a sharp increase in deposit formation after this point is reached. Other oils will go through the stages shown in the photograph. These oils will show a lower rate of deposit increase during that portion of the test period that the oil soluble products are retained.

There is some question whether this is true solubilization or whether these oil-soluble oxidation products may, under engine operating conditions, act to some degree as dispersants. In either case, it is a definite and beneficial performance characteristic and should be considered in evaluating additive performance, but given less weight than inhibition and dispersancy.

Combining the results of the centrifuge sludge dispersancy tests with the data previously shown in Fig. 6 permits us to make a relative comparison of the additive performance characteristics of these oils, as shown in Table 2. We have not attempted to weight the relative importance of the different factors but have merely ranked the oils in the order of their performance.

This type of information has proved quite helpful in selecting and balancing additive combinations for new oil formulations.

To Order Paper No. 126T . . .
. . . on which this article is based, turn to page 6.

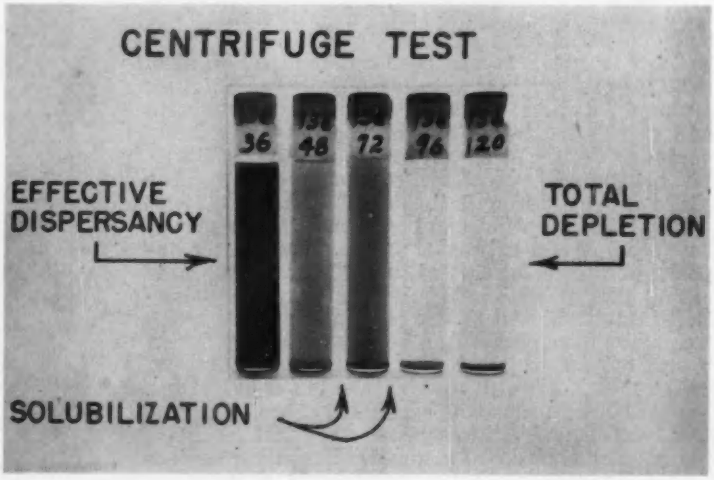
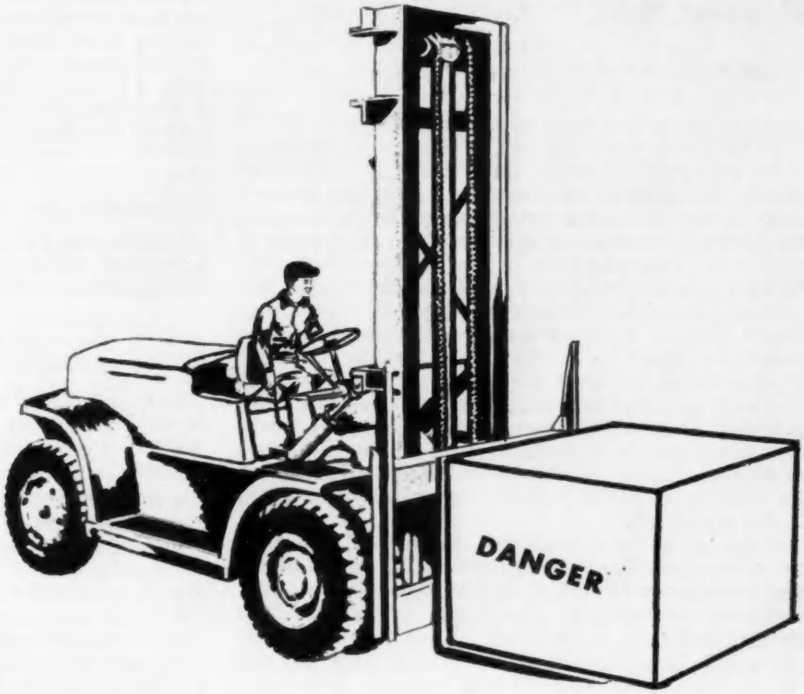


Fig. 7



Space–Age Materials Need Kid–Glove Handling

Based on panel report by

Marc Worst

Lockheed Missiles & Space Division

MANY space-age materials present materials handling problems. Explosion, radioactivity, fire, corrosion, asphyxiation, warping, marking, and skin diseases are among the hazards of handling these materials.

The definitions of these items and the control approaches mentioned in this article are those used by the Lockheed Missiles and Space Division. Every new material must be examined to determine if any new hazards are presented so that suitable instructions for safe handling may be prepared immediately. This is usually a joint effort of the Safety Engineer, Health Physicist, the department requesting the material, and the Materials Department. This study is intended for general information only and each company should prepare its own handling procedures, as safety precautions must always remain the responsibility of the company concerned and should not be merely copied blindly.

This article describes the hazards associated with, and the handling of, the following problem materials:

1. Dangerous materials.
2. Explosives.
3. Radioactive materials.
4. Magnesium thorium.
5. Beryllium.
6. Teflon.
7. Metal-clad plastics.
8. Extremely delicate units.
9. Environmental-problem units.

Dangerous material

Dangerous material is that material which, by virtue of its properties, could do bodily harm and could damage property if not handled and stored with special caution. For example: acids, and flammables such as fuels, non-explosive time delay switches, and fuse lighters. Most of the new liquid missile fuels, in particular UDMH (unsymmetrical dimethylhydrazine), are among the new dangerous materials.

Lockheed's basic control procedures for the han-

Space-Age Materials Need Kid-Glove Handling

. . . continued

dling of dangerous material are as follows:

1. All paper work relating to dangerous materials must be clearly labeled "DANGEROUS." This includes the original request from the using department to Stores, a request to purchase by Material Control, the Stores and Material Control records of inventory, the purchase order, the vendor's containers and shipping papers, all Shipping and Receiving paper (both in and out of the plant and between plants), and each issue document. This constant alert to all personnel involved in the handling of dangerous material is a vital part of the total vigilance required for safe handling of this material.

2. Containers of dangerous materials are clearly identified by a visible description of the materials and their danger points (including flash point for flammable materials and compressibility for gases under pressure).

3. Dangerous materials are stored in a safe area under application of storage compatibility principles and withdrawn for use by qualified employees only. Cabinets containing flammable materials are painted red.

Explosives

Explosives are defined as any mixture or compound which, under the influence of heat or mechanical action, undergoes a sudden chemical decomposition change with a liberation of heat and light energy and a large volume of gases. Examples of articles of explosives: bombs, rockets, JATO's, electric igniters, primers, detonators, percussion or electric caps, matches, squibs, flares, cartridges, and black powder.

Considerable reference material is a part of the control of explosives, and Lockheed Missile and Space Division (LMSD) regulations make frequent reference to Air Force Regulation 86–6, Air Force Technical Order 11A–1–34, and State of California General Industry Safety Orders. These controls are particularly concerned with:

Quantity-Distance:

The distance from a location, such as an inhabited building, public railway, magazine or operating building, required to protect that location against substantial structural damage from ignition or explosion of the quantities stored.

Storage Compatibility:

Two or more explosive items are compatible for storage when their characteristics are such that the hazard from a comparable quantity of any of the items, stored together, does not increase the normal hazard. For example: Pyrotechnics should not be stored with any quantity of black powder.

To alert everyone to the presence of these explosive materials, each piece of paperwork is overstamped "EXPLOSIVES." In addition, adequate instructions in the handling of explosives must be given to every employee required to handle them. Careful provisions must be made for the disposition of unserviceable explosive materials, after clearing with the appropriate military authority. An Air Force form 191, "Ammunition Disposition Report," may be required.

Radioactive material

Radioactive material includes three categories as defined by the Atomic Energy Act. It also includes any material containing one of the following:

1. Byproduct material
2. Source material
3. Special nuclear material

As in the case of explosives, considerable reference material is necessary as part of new control procedures, and we particularly find these publications necessary:

- Atomic Energy Commission Distribution Regulation, Title 10, Page 30
- California General Industrial Safety Orders, Article 53
- Air Material Command Manual No. 160–2
- USAF Technical Order O–110A–1
- Code of Federal Regulations, Title 10, Chapter 1, Part 20 entitled "Standard for Protection Again Radiation," and Part 40 entitled "Control of Source Material"
- Atomic Energy Act

Since the subject of radioactive materials is such a critical one, LMSD Radiation Hazard Committee has prepared a complete handbook on the subject as a working consolidation of these references. Basically, it provides for the following: The AEC has exacting regulations for handling radioactive materials, wherein LMSD is required to:

1. Apply to and receive from AEC a license in advance of procurement of radioactive materials.
2. Keep material accountability records reasonably detailed by licenses, receipts, transfers, losses, inventories, locations, and such.
3. Establish and maintain appropriate safety controls.
4. Have material records and safety controls available to AEC review and approval.

Violations of regulations are deemed as violations of the Atomic Energy Act, which prescribes severe penalties. All supervision is responsible for assuring compliance with this procedure and for any other action needed to foster LMSD's obligations under AEC regulations.

Again, from the material standpoint, all paperwork from the first initiating document to the ultimate disposition document must be clearly noted with "RADIOACTIVE — NORMAL HANDLING" or "RADIOACTIVE — HAZARDOUS HANDLING." Moreover, vendors, both on their containers and paperwork, must be required to note the rating per the applicable regulations. Throughout the entire material handling cycle, items noted "Radioactive — Normal Handling" should be guarded in accord-

ance with the basic instructions from the Safety Engineer. But items marked "Radioactive — Hazardous Handling" require that the Health Physicist or the Safety Engineer be immediately called for instructions and personal surveillance.

Magnesium thorium

Magnesium thorium alloys have gained popularity as a structural material in missiles. When alloyed with 2–3% of thorium, magnesium gains good high temperature properties. However, magnesium thorium presents a dual hazard to industry. Still basically magnesium in content, it still retains the same fire hazards (especially in sawing and grinding operations) and corrosion problems (particularly when stored in salt moisture atmospheres) as the parent metal magnesium.

Thorium is a radioactive material, so magnesium-thorium alloys are also slightly radioactive. Though the problems with this material are much less serious than with some other radioactive materials, it is still necessary to take some precautions.

It is essential that men working with magnesium-thorium alloys have a practical knowledge of what the alloys are, their radioactive properties, the problems associated with them, and the necessary precautions.

The radiation problems due to radioactive materials can be divided into two groups, those due to external radiation, and those due to internal radiation from radioactive materials inside the body. Because of the small amount of thorium in magnesium-thorium alloys and the low activity of the thorium, radiation to the body from magnesium-thorium outside the body is very low. So the main concern is with magnesium-thorium that gets inside the body through lungs, mouth, or skin.

The main radioactivity problem with magnesium-thorium alloys is the breathing of fumes and fine dust. Small particles, about 1/25000 in., can penetrate deep within the lung. Some will be retained there, and can be absorbed further into the body. This is the most likely means for entry of radioactive material into the body. Control measures must be aimed at preventing excessive intake.

From the standpoint of material, we find:

1. Again, all paperwork must be carefully controlled by markings of "RADIOACTIVE — DANGEROUS" from the initial request to final disposition.
2. In LMSD handling of magnesium-thorium heavy plate, we saw the plate in Material to size for issue; therefore, in the operation of our saw equipment, we must observe the same fire and radioactive precautions which the shop uses and as outlined in our specific magnesium-thorium control procedures.
3. Since magnesium-thorium is fully accountable to the AEC, and is also fairly expensive, we must use considerable care and control in segregating and disposing of the scrap.

Beryllium

Beryllium is the lightest usable structural metal. Though its machining characteristics are poor, it has excellent stiffness-to-weight and high temperature characteristics which make it a valuable material for the aircraft and missile industry.

The basic hazards that are encountered in working with beryllium are:

1. A respiratory problem results from excessive exposure to above tolerance concentrations of beryllium in the form of dust or fumes in the air.
2. Any cuts or open wounds implanted with beryllium or its compounds tend not to heal until the foreign matter is removed.
3. A temporary dermatitis condition can be caused by some of the compounds of beryllium.

The respiratory problem is the most serious of the three and, therefore, we work within the recommended AEC limits for beryllium concentration in air.

From a material handling standpoint, all documents are overstamped "DANGEROUS" to ensure the maximum caution at every step.

Teflon

Teflon is a trade name for polytetrafluoroethylene resin. It is an excellent insulating and gasketing material for highly corrosive and reasonably high temperature environments.

Teflon in its solid form is inert at normal temperatures. Contact with the solid form, chips, grains, or dust has no detectable effects.

Vapors from heated Teflon, however, can cause serious illness when significant amounts are breathed. The illness generally takes a form similar to influenza, with chills, aches, nausea, and fever. In such cases, medical care is necessary.

The vapors or fumes are generated when Teflon is heated to over 400 F. The higher the temperature, the more fumes are generated. Operations such as molding, heating, soldering, high-speed machining, grinding, and the like can produce these fumes. Teflon dust or chips can also cause difficulties if they happen to contaminate personal smoking materials such as cigarettes. In Material we use the "DANGEROUS" overstamp and also are quite concerned with the scrap disposal of Teflon, lest it be mixed in burnable trash, with a resultant public fume hazard.

Metal-clad plastics

Metal-clad plastics are finding use in printed circuity.

These materials, unlike the previous materials, pose no safety or health problem, but must be carefully handled. Some of the hazards in handling include:

1. The bond between the copper and its backing can be damaged by careless handling.
2. The boards can warp if stored unevenly.
3. Finger marks on the copper face frequently cause corrosion in storage which is expensive and sometimes impossible to remove. Corrosion causes minute pitting of the surface. This can mean electronic or soldering problems that result in high rejections of raw materials or completed circuit boards.

Delicate Electronic or Mechanical Units

Much care is required in handling delicate electronic equipment and instruments, particularly

Space-Age

Materials Need Kid-Glove Handling

. . . continued

those of a gyroscopic nature. Rough handling must be eliminated and shock reduced to an absolute minimum. In addition, care must be taken to see that dust and dirt don't contaminate such mechanisms.

An even higher order of care is needed for many of the more recently developed items for the missile and the space vehicle field. Particularly noteworthy are the transducers and accelerometers.

These transducers and accelerometers range in price from $400–1000, are generally about the size of a package of cigarettes and are extremely sensitive to shock. After experiencing much rework for damage, LMSD devised a Delicate Instrument and Transducer Handling Procedure. This procedure revolves around a specific unit package, with specific packing therefor. It calls for procurement negotiations for packaging the instrument at the vendor's plant in a polyethylene bag inside the container and then marking it. When such a marked package is received at LMSD, it is moved without opening directly to the functional test lab where it is opened and tested in a controlled atmosphere. It is then re-packaged, sealed, and only reopened at the actual point of use. All transportation for such units are equipped with semi-pneumatic tires for shock absorption. A special marked-off area is provided for storage and personnel manning this area are selected and trained to handle these packages.

Environmental-problem units

For years, we have campaigned for dry-humidity warehousing for raw materials. For rubber goods, we have looked for dark, cool areas. Certain liquids and gases have required modest temperature limitations.

But, much more exacting material environmental requirements are with us today. Both solid and liquid missile propellents are frequently sensitive to storage temperature range. The new fluid-floated extreme precision inertial guidance units used at LMSD are floated in melted wax, which must be always kept at a certain heat whether in use, in storage, or in transit. If this wax is allowed to even slightly cool, and thus coagulate, tiny connection wires suspended therein can snap immediately upon any movement, necessitating an expensive disassembly for repair.

Others serving on the panel on Materials Handling, in addition to Mr. Worst, were: chairman **M. E. Griffey**, Nortronics-Northrop; co-chairman **W. E. Kappler**, North American Aviation, Inc.; **H. S. Cooper**, Nortronics-Northrop; **J. C. King**, Convair-Astronautics; **C. R. Blomquist**, Missile Division, NAA.

(This article is based on a report of one of 16 production panels on missiles and aircraft subjects. All 16 reports are available as a package as SP-329. See order blank on p. 6.)

OPTICS–Engineering

Based on report by secretary
J. D. Ryan
Ryan Aeronautical Co.

OPTICS is being used as an aid to engineering and research. This article describes three applications where optical principles were used to improve a product, reduce costs, or both.

Shrinkage measurement

The first case involves an apparatus for the continuous measurement of shrinkage at high temperatures using principles of the optical lever. What was needed was a technique for measuring the shrinkage of a powdered metal block being sintered at temperatures of 900–1300 C in a furnace.

Two inclined planes with mirrors attached normal to each inclined surface were located at either end of the block. One end of each inclined plane rests on the powdered metal block and the other end on the surface on which the block is placed. Telescopes are auto-collimated to the mirrors and then focused on a scale. When heat is applied to the block, any shrinkage taking place is multiplied 70 times at the point where the line of sight reflected off the mirror intersects the scale. The scales and telescopes at each end of the block are set up outside of the furnace and average readings of the two scales are taken.

This is an application where extreme accuracy is obtained and where another method could not be used with accuracy due to the heat problem.

Radome alignment

Through the use of optics, positive alignment and correct relationship of the elements of a radome bore sight antenna range can be accomplished. The two units to be aligned are located 130 ft apart, and a line of sight is substituted for the electrical range axis.

In testing radomes for variations in electrical densities, and such, it is essential that the electrical axis of the test range, the gimbal point, and the null

Third Eye to and Research

seeker center be coincident. In addition, the angular relationship of the various elements must be determined. To do this required three basic optical principles:

1. Focusing to an optical target to measure displacement deviation.
2. Using collimation to establish parallelism.
3. Using auto-collimation to establish precise 90 deg angles.

Using these optical principles, radomes were tested with accuracy that would be nearly impossible by other means.

Photographing shock waves

Case three is an optical device designed to enable research scientists to photograph shock waves generated by projectiles traveling several times the speed of sound. The unit employs a combination of optical and electronic elements to accomplish the purpose and is known as the Schlieren System.

Through a series of mirrors, a flash from a spark gap is directed across the path of the projectile. A camera mounted on the opposite side of the unit is focused on a parabola mirror through a pin hole orifice. The projectile interrupts a beam of light trained on a photoelectric cell to trigger the spark. The open-shutter type camera automatically records the picture when the spark occurs.

To measure the speed of projectiles, a second triggering unit and a timing device are added which measure the time interval between the interruption of light beams at two known points.

Serving on the panel which developed the information in this article, in addition to the panel secretary, were: chairman **M. J. Martin,** Ryan Aeronautical Co.; co-chairman **Don Crayton,** Convair Astronautics; **Walter White,** Nortronics-Northrop; **Frank Sladek,** Convair Division, General Dynamics Corp.; and **T. J. Vajda,** Lockheed Missiles & Space Division.

(This article is based on a report of one of 16 production panels on missiles and aircraft subjects. All 16 reports are available as a package as SP-329. See order blank on p. 6.)

Basic concepts of

Auto-collimation

The auto-collimator is an instrument for the precise measurement of small angular deflections of a light beam.

It consists essentially of a telescope which produces a collimated (parallel) beam of light. This light beam originates from a small lamp attached to the side of the telescope and is reflected along the axis of the telescope by means of a beam splitter.

Crosshairs placed in the focal plane of the telescope objective lens are illuminated by the beam of light. The image of the crosshairs would thus form at infinity unless interrupted by a reflecting surface.

Accurate reading of small angular deflections is provided by a micrometer microscope eyepiece fitted on the telescope. The entire telescope assembly is supported on a stable base which is adjustable about the horizontal or vertical axis.

If a suitable reflecting surface is placed normal to the light beam, the beam and crosshair image will be reflected back into the instrument allowing the observer to compare the image with the real crosshairs.

When the mirror is maneuvered so that it superimposes the image on the crosshairs, the mirror will be normal to the light path of the auto-collimator to an accuracy of less than one second of arc.

Truck Wheel and Tire

Goal Is Raising

This article is based on the following eight papers, which, as a group, comprise SP-171:

"Chevrolet's Approach to Truck Tire and Wheel Problems"
by George J. Mach
Chevrolet Motor Division, General Motors Corp.

"Effect of Tire and Wheel Runout and Balance on Motor Truck Ride Characteristics"
by C. A. Carlson
International Harvester Corp.

"Wheel Runout and Balance"
by John N. Bradley
Budd Co.

"Manufacturing Procedures for Automotive Truck and Trailer Wheels"
by S. A. Malthaner
Gunite Foundries Corp.

"The Tire Engineer Looks At Truck Tire Balance"
by T. A. Robertson and C. E. Stair
Firestone Tire & Rubber Co.

"Truck Tire Balance and Runout"
by M. A. Wilson and J. A. Schleich
Goodyear Tire & Rubber Co.

"An Operator's Experience With Tire and Wheel Runout Problems"
by J. H. Dolan
Burlington Truck Lines, Inc.

"Tire and Wheel Balance Problems For an Over-Road Carrier"
by Lloyd Hurst
Norwalk Truck Lines of Delaware

THE truck industry is striving to attain unbalance limits for wheels and tires comparable with those of passenger cars. This is essential if drivers are to have comfort on modern high-speed roads. Good balance will also bring economies in the manufacture of tires.

Importance of wheel balance

There are several factors involved in controlling the balance of wheels. First, it must be known whether the runout is caused by ovality (variation in diameter of an object having no center, like a rim) or by eccentricity. If runout is caused by ovality, it will have no effect on balance, but if caused by eccentricity it will have a direct effect on balance, not only of the wheel but of the tire as well.

Each 1/16 in. of runout caused by eccentricity results in 100 oz-in. out-of-balance for each 200 lb of tire and wheel assembly. Balancing the wheel alone corrects only 10–30% of the assembly out-of-balance caused by eccentricity. The most important feature of a wheel is the trueness of its center, not the ovality, nor the out-of-balance.

Wheels that are perfectly true can be made by tool room methods, but the costs would skyrocket. So the ultimate goal is to produce a wheel with as little runout or out-of-balance as is economically feasible. In the meantime, the best thing to do to improve both assembly balance and runout is to match the heavy spot on the wheel with the light spot on the tire.

Role of tire in balance

Tire producers are vitally interested in improving precision in manufacture. More uniform tires mean not only better balance but also economies in manufacture. If a tire has excessive gage buildup due to poor distribution of material, it implies excessive use of material. For example: a 10.00-20 truck tire which is 200 oz-in. out-of-balance has at least a

Unbalance Getting the Works

Driver Comfort Level

pound of unnecessary rubber and fabric somewhere around its circumference.

All other factors being equal, the degree of average unbalance to be expected in a truck tire is in proportion to the size and weight of the tire. Actually, the degree of unbalance of current production truck tires falls pretty well in line with that of smaller size passenger-car tires. This was found when the average unbalance of more than 65,000 tires of various sizes was plotted against the product of tire weight times tire radius.

Fig. 1 presents the frequency of distribution curve based on unbalance measurements of about 5000 tires in the 9-22.5 and 8.25-20 size category. The bulk of the production sample can be seen to be well under government specification limits. However, some did exceed the limit and it is those that the tire manufactures want to see eliminated. Of course, even if all tires were perfectly balanced when new, there might be a change with wear or retreading. Therefore, weights on the rim flange appear to be the most practical solution over the life of the vehicle.

Measurements taken on a group of highway truck tires show the average radial runout to be about 0.05 in., regardless of tire size. This is in the same range as passenger and racing tires. Actually, truck tire runout is usually less than that on the wheel and rim assemblies on which the tires are mounted.

Wheel components as offenders

Chevrolet made a study of hubs, brake drums, wheels and tires — 24 sets of components — to determine the amount and effect of unbalance and wheel runout. This is what was found:

Hub: Average physical unbalance was 8.73 oz-in.; average runout 0.037 in. In 11 instances the diameter which locates the brake drum was 0.0022 in. undersize, which could account for 2.96 oz-in. of unbalance in hub and drum assembly. The studs were not parallel to the hub and eccentricity was 0.030 in. In a final assembly of an average 160-lb wheel and tire unit, this misalignment could cause 76.8 oz-in. of unbalance.

Brake Drum: ID for locating drum on hub was within accepted tolerance, but unmatched exterior surfaces of drum indicated an average runout of 0.070 in. Physical unbalance in the 24 pieces averaged 42.66 oz-in.

Wheels: Runout was as much as 0.070 in. at the bead seats. Average unbalance of all wheels was 20.22 oz-in.

Tires: Their lack of uniformity made them the major cause of unbalance in the front end assembly. Test tire sizes was 10-22.5 10 ply. Wall thickness

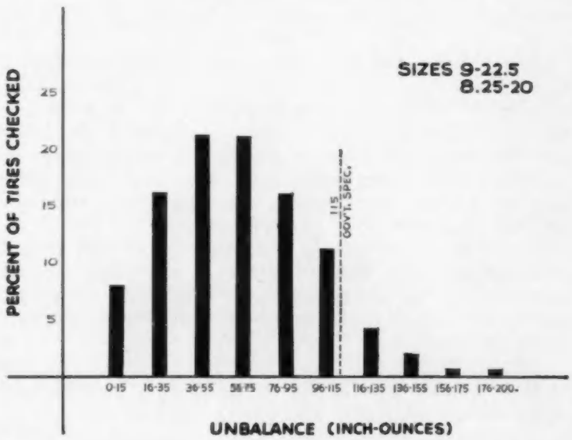


Fig. 1 — Distribution curve of unbalance measurements of about 5000 truck tires shows bulk of them falling well within government specification limits. Goal is to make all tires conform.

Truck Wheel and

Tire Unbalance

. . . continued

varied 0.096 in.; runout averaged 0.055 in. on the OD and 0.083 in. on the casing sidewall. Tire out-of-balance ranged from 126 to 260 oz-in.

Application of study findings

Efforts to develop a method for improving balance without restoring to a balancing operation proved unsuccessful and the conclusion was reached that solution to unbalance and runout conditions lay in improved designs and new, higher quality standards for the rotating components. Moreover, to keep total unbalance within newly specified limits, an assembly plant balancing operation for all front hub, brake drum, and wheel and tire assemblies was thought necessary.

A concentric base for mounting the wheels is essential for a true-running front end. To center the wheel properly on the hub, new tolerances are specified for light-duty hub assemblies which control the bolt circle-to-spindle runout to 0.010 in. TIR (total indicated reading), and rim bead seat-to-bolt circle runout to 0.060 in. TIR. A 0.005-in. tolerance is specified for the hub mounting surface-to-spindle dimension, while the rim-bead-to-mounting surface runout is limited to 0.060 in. on light-duty models and 0.090 in. on heavier vehicles.

On medium- and heavy-duty models, disc wheel hubs and cast spoke wheels incorporate a wheel or rim pilot. The new disc wheel pilot consists of five equally spaced shoulder lugs cast into the hub assembly, so designed that a tool can be inserted between the wheel ID and hub for easy wheel removal. To minimize eccentricity, a tolerance of 0.005 in. TIR is specified for hub pilot-to-spindle runout. The rim pilot on cast spoke wheels consists of a machined seat at the outer extremity of each spoke. Rim pilot-to-spindle runout is limited to 0.003 in. TIR.

A washer-based nut wheel attachment replaces a tapered-nut attachment on medium-duty models. The wheel is properly centered on the hub by the piloting lugs, and the washer-based nuts perform the single function of attaching the wheel firmly to the hub and drum assembly. The attaching nuts provide a wide contact area with the wheel, thus reducing the stresses at the stud holes.

Since the new wheel assemblies are not interchangeable with those used with the tapered-nut attachment, some problems are expected. However, the many advantages make an early, wide acceptance probable.

Out-of-balance in front hub and drum assemblies is now limited to 6 oz-in. on light-duty models and 10 oz-in. on medium- and heavy-duty models.

To Order SP-171 . . .
. . . on which this article is based, turn to page 6.

Targets for

Based on paper by

R. K. Super
Timken-Detroit Brake Division
Rockwell-Standard Corp.

BRAKES that require no attention between relinings are a reality for passenger cars and are being developed for heavy-duty commercial vehicles. The elements of such brake design are reasonably simple. They are:

- Maximum lining life.
- No periodic lubrication.
- Weather sealed for uniform performance.
- Automatic adjustment.

Extended lining life appears to be the important single aspect of the economics of brake equipment, but there is a broader concept. This concept is outlined by eight points regarding extended service life and periods between adjustments on which agreement was reached at a meeting in 1955 by the AMA-TTMA Subcommittee on Service Brake Design for Tractor-Trailers.

The eight points are presented as they appeared in the report and are followed by comments which will elaborate on them:

Point 1 — Maximum capacity in the brakes on the vehicle or combination may be obtained by providing brakes on all wheels.

Comment — Use of brakes on all wheels has been recognized as desirable but not completely acceptable because of the problem of front wheel brake control. The proportioning of front brake power to secure optimum brake control and capacity, free of driver selection, would improve braking immeasurably through the efficient use of brakes on front wheels.

Point 2 — Maximum capacity of brakes on the vehicle or combination requires synchronized braking on all axles.

Comment — Synchronizing involves two phases. The first relates to the delivery of the actuating medium at the same time at all locations in the system. Suitable valves and installation techniques are available for realizing this objective. The second phase involves power distribution. This is par-

Better Heavy-Duty Brake Design

ticularly critical with commercial vehicles because of the variable conditions of loading. The partially or unequally loaded vehicle creates an even more serious problem than the difference in load distribution between the fully loaded and the completely unloaded vehicle. Much successful work has been done with load valves, which proportion brake power in relation to wheel load.

Point 3 — The use of the largest size brakes within the space limitations should be a further objective.

Comment — This does not necessarily mean maximum brake lining area because this factor does not directly indicate brake capability. Brake size also is related to the efficiency of the design when operating in the space available. On many installations a brake of smaller diameter will have a greater life than a larger one because of tire-rim size. A combination of brake size and the design of the companion brake drum will produce the best results.

Point 4 — Maximum cooling of the brakes through consideration of wheel design, tire-rim sizing, and wheel shrouding would be a further contribution to extended service life.

Comment — Careful attention to the environment in which a brake operates will add to its life. Natural circulation inside the brake and over the drum should be made possible by exposure to the air stream. This means minimum use of dust shields on the brakes or wheel shrouds.

Point 5 — Power actuated components should be selected to provide maximum reserve and be limited by the space available and the possible penalizing of the application time.

Comment — The selection of power units can contribute much to provide added reserve travel in the actuating components to give a greater margin for followup, which is necessary to compensate for drum expansion and obtain uniform performance with less frequent adjustments for lining-drum clearances. Needlessly large units will result in a greater stopping distance. It is in this phase of design that automatic clearance adjustment is very much needed, and recent progress in this direction is encouraging.

Point 6 — Serious consideration should be given to the use of supplementary brakes, such as retarders, to obtain extended life for vehicle brakes.

Comment — The use of retarders is complicated by cost, weight, and space required for installation. The adverse load effect on drive line components also deters their wider use. The need for this type of device is created by the desire to negotiate grades at speeds in excess of those which would permit use of the engine in the lower transmission gear ratios where it is effective as a load retarder. It is the loss of engine holding capability at desired road speeds that is a major contributing factor to current service brake problems.

Point 7 — The introduction of limiting downhill speeds to handle the vehicle or combination within the capacity of the brakes would be an important contributing factor to extended service life.

Comment — The optimum capacity of all braking units on a vehicle would be that which permitted the safe control and operation on any grade at any desired speed. The vehicle load and speed in relation to the grade would establish the required brake capacity. Legal limitations on load and speed do not necessarily make the brakes completely adequate for the "allowed" conditions. Further, it is axiomatic that any vehicle brake that will safely stop the unit is adequate in capacity for some specific vehicle load and speed. These may be lower than desired, in which case the economics of safe operation will establish the relationship of brake size or capacity to the vehicle speed and weight.

Point 8 — A realization that more complex problems involving the economics of brakes have resulted from higher scheduled speeds, greater engine horsepower, and higher gross vehicle and combination weights.

Comment — Higher horsepower and automatic transmissions have complicated the economics of brake equipment. The combination makes possible more rapid acceleration, and the time intervals between brake applications are shorter. Grades can be ascended at a higher speed with subsequent reductions in time. Uphill time is the cooling off time for brakes. As this time is shortened, the temperature of the brakes is higher at the start of the next descent.

To Order Paper No. 117U . . .
. . . on which this article is based, turn to page 6.

Single-Skin Sandwich for hot parts is strong, light

New type of structural foil is all spotwelded; reduces manufacturing problems.

Based on paper by

M. J. Breitenbach and Brooks Lake

Ryan Aeronautical Co.

The Authors

M. J. Breitenbach has spent 18 years in the aircraft industry since receiving a B.A. in Physics from Cornell and B.S. in Aeronautical Engineering from the University of Michigan.

His areas of experience include aerodynamics, hydrodynamics, dynamics, stress analysis, and structural layout design.

He is a design specialist at Ryan, working on structural research and development of light-weight structures built of high-temperature resistant materials.

Brooks Lake, who is a graduate Aeronautical Engineer from the Northrop Institute of Technology, is with Ryan's Structures Department.

He is doing development and research work on foil-gage, spotwelded structures; and is conducting and handling all testing on the Ryan MiniWate program.

MINIWATE — a single-skin, foil-gage, corrugation-stiffened structure for use at high temperatures — is as strong as an equal weight of double-skin brazed sandwich construction. It eliminates blind spot welds, simplifies inspection, and reduces manufacturing costs. Any spotweldable, high-temperature material can be used. The structure is all spot-welded, thus eliminating the development problems associated with new brazing techniques.

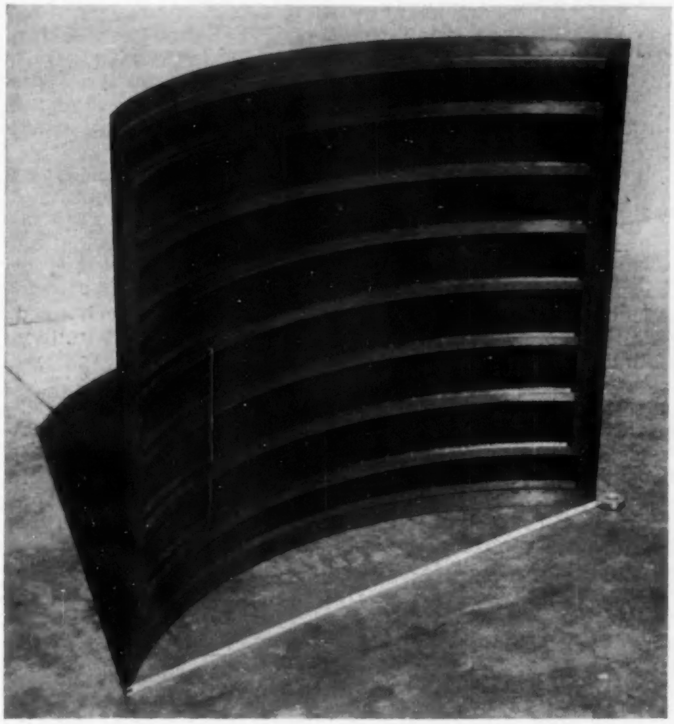
Manufacturing costs (in production quantities) will be under $200 per sq ft — less than those for honeycomb construction.

In fact, this construction is limited only by the temperature range of the material and its availability in foil gages.

Structure easily manufactured

The structure consists of a single skin which is resistance spotwelded to a sheet of miniature corrugations. Typical dimensions are shown in Fig. 1. Miniature corrugations are necessary to maintain the low width-to-thickness ratio needed to work the foils to the highest possible allowables. With the No. ½ corrugation of Fig. 1, it is possible to work with foil gages as low as 0.00025 in. By proper use of corrugation and skin combinations, compression stresses of over 75% yield strength may be obtained.

The spotwelding technique eliminates the weight of brazing material; makes possible a larger choice of high-temperature structural materials; and exposes joints. Much less research time is required to learn how to spotweld a material, than to braze it. The same basic technique and welding machines can be used to handle most metals in all foil



Experimental Panel for B58 Engine Pods

gages. It is mainly a matter of adjusting pressure, amperage, and time to obtain a satisfactory weld in a given material.

Spotwelding can bond multiple strips . . . a single spotweld has handled over 10 sheets of foil gage material (Fig. 2).

Joint fatigue problems solved

Many failures were analyzed to develop satisfactory joints to make the miniature corrugation concept practical. This research resulted in compression and shear-tension joints which can satisfactorily withstand fatigue cycling at reasonable loads.

An experimental curved panel for B58 engine pods (see top of page) was subjected to compression loads to test local failure at the point of load application. A finger joint (Fig. 3) was developed in which the finger thickness was about equal to the equivalent thickness (weightwise) of the skin-corrugation combination. The finger joint successfully withstood 200% of the desired compression load.

All structures involving compression joints now use this finger design . . . and local compression joints are no longer a problem.

The panel was also subjected to high-level noise at its natural frequency of about 368 cps. After 68 min of operation at 161 db, the panel began to separate from the stiffening frames and the spotweld nuggets began pulling from the saddle-attached corrugations.

A joint fatigue program was initiated, in which the failed joint was simulated. In this joint a

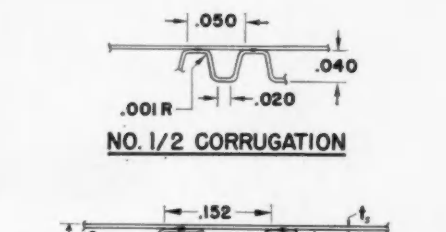


Fig. 1 — Typical corrugations.

Single-skin sandwich for hot parts is strong, light

. . . continued

saddle corrugation is first spotwelded to the frame, and the ends of the corrugation — which extend past the frame — are then spotwelded to the skin-corrugation combination. A joint with no blind spotweld attachments results.

These joints were cycled in a 25-lb fatigue test machine under full load reversal at approximately 1800 cycles per minute. Specimen length was varied until it failed at the same number of cycles (about 1.2 million) at which the B58 panel failed. This corresponded to a loading of 25 lb per in. of frame.

Test results and calculations revealed the reason for damage. . . . Light-weight panels often have a natural frequency in the 100–1500 cps range. This range is the same as that of the jet engines, and in this area the noise level energy is greatest. It is, therefore, necessary to design for 15–20 times the maximum sound pressure developed because of the decibel level. Fig. 4 shows a curve of peak sound pressure versus decibels.

The cracks originated in the saddle corrugation at the juncture with the frame attachments, and resulted in reduced structural stiffness. This reduced stiffness overloaded the joint spotwelds and caused their failure. The problem was solved by reducing the saddle length and increasing its thickness so that the total saddle weight was unchanged.

The revised joints can now survive 10 million cycles at room temperature up to 25 lb/in. full load reversal.

An intercostal joint (Fig. 5) is also being developed. It is expected to be standard for both shear and tension loads in the near future. This joint is a miniature of a standard joint between frames and skins around stringers for normal aircraft construction. The saddle joint is slightly better than the intercostal type when subjected to tension loads . . . however, it has a tendency to roll when subjected

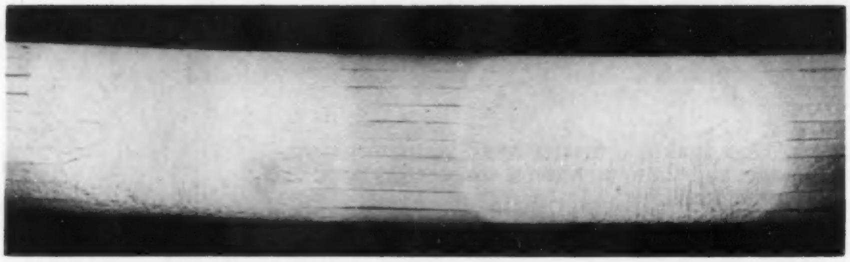


Fig. 2 — Spotwelds through 10 strips of 0.008-in. all beta titanium.

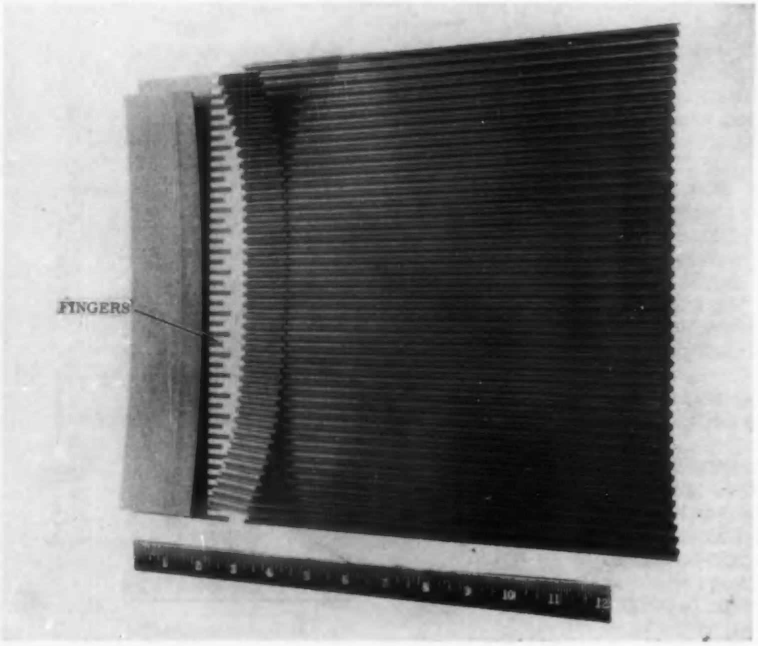


Fig. 3 — Finger joint for compression loads.

to shear loads. There is no blind attachment problem with either saddle or intercostal joints, and they are lighter than the heavy slugs or build-ups required in double skin construction.

How it stands up

Single-skin construction can carry equal or greater bending moment than double-skin construction without a weight increase. In some cases, however, double-skin construction may be more efficient for columns or deflection problems, because they have higher moments of inertia per unit of weight.

These structures can withstand high heat rates without serious distortion. Panels were tested by varying their distance from a bank of quartz lamps, thus adjusting their temperature. For example, heat was applied to a panel consisting of 0.0006 in. skin stabilized by 0.003-in. No. 2 corrugation. (The material was 17-7PH heat treated to the RH950 condition.) Fig. 6 shows the time-temperature history of the panel. Surface buckling was very small.

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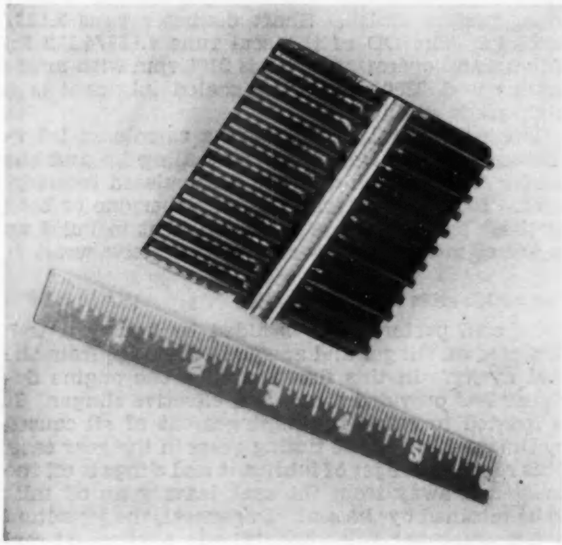

Fig. 5 — Intercostal joint.

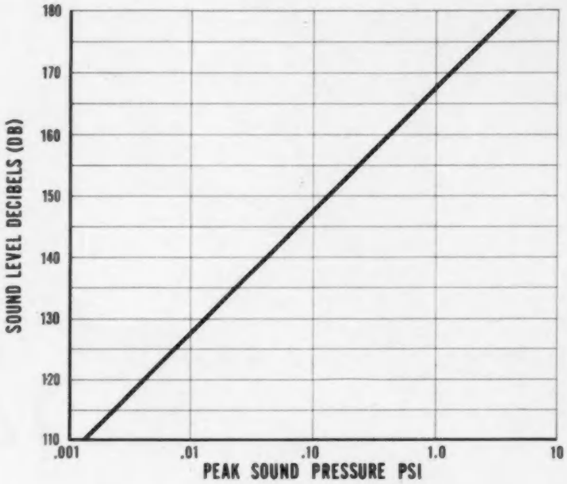

Fig. 4 — Peak sound pressure versus decibel level.

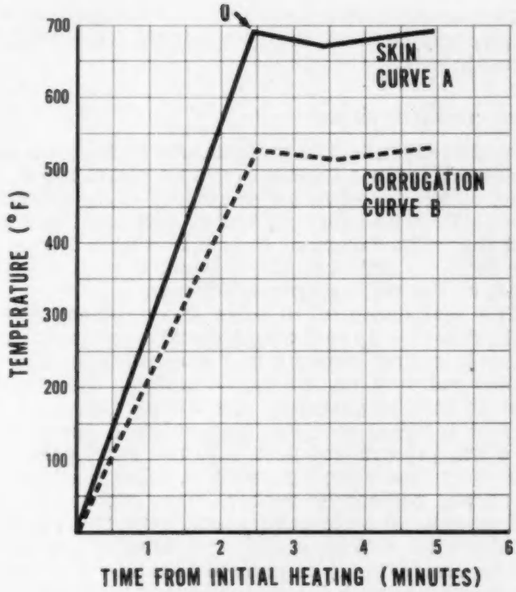

Fig. 6 — Time-temperature history of high temperature rate test made on panel — with very low distortion. Curve A shows temperature of skin surface; Curve B shows the temperature of the corrugation at the extreme fiber on the opposite side of the panel. Peak skin temperature is shown at point O; maximum temperature gradient was 162 F.

Engine Oil Seals

To Meet Truck and

Based on paper by

S. M. Lillis

Victor Mfg. & Gasket Co.

NEW MATERIALS, methods, and machinery are being used to make oil seals for truck and bus engines that will stand up under the punishment imposed by today's operating conditions. In the face of sustained high speeds, often in rugged terrain or in hot climates, seals of older design may fail.

To illustrate advances in oil seal design, two examples will be cited, the first being a front seal for a crankshaft.

Front crankshaft oil seal

In this example, the problem was to design a seal to substitute for a leather seal, in a diesel truck engine, which failed in an extremely dusty environment. Dust and dirt packed in between the shaft and the leather element to interfere with flexing of the seal. In addition, the dust acted to groove the shaft at the sealing lip contact point.

The seal designed to solve this problem had a molded double lip seal with a metal outer case. The molded sealing element had a continuous film of rubber running up the inside wall of the bonded case to form a gasket at the toe of that case. A perfect internal seal was formed after the bonded case was pressed, toe first, into the outer case and the outer case clinched securely. The sealing element was polyacrylic rubber. This rubber has excellent hot oil resistance which kept the element flexible after 2000 hr of high-temperature operation.

The seal (Fig. 1) is pressed into the gear train housing cover with the spring loaded sealing lip toward the oil. The auxiliary or dust lip is toward the outside or front of the engine. The two lips are engaging the vibration damper flange hub which is installed over and locked onto the tapered and keyed front end of the crankshaft. The hardness of the hub runs 45–55 Rockwell C with a 16-microin. maximum surface finish. Shaft diameter runs 3.123/3.127 in. The OD of the seal runs 4.128/4.132 in. The normal operating speed is 2100 rpm with maximum speed 2300 rpm. The sealed lubricant is a high-grade engine oil.

The seal is designed to have a calculated interference between the ID of the sealing lip and the shaft. The dust lip also has a calculated interference. Too much interference of either one or both of these lips will cause frictional heat to build up in the element and may result in excessive wear.

Two essentials in design

Oil seal performance is aided by having a well designed oil slinger and adequate drainage from the seal cavity. In this first example, the engine designer has provided a fine and effective slinger. It is located to catch the impingement of oil caused by the meshing of the timing gears in the gear case. This receives the jet of lubricant and slings it off the shaft and away from the seal, leaving an oil mist to be retained by the seal. In general, the jet action of lubricant has a detrimental effect on an oil seal if no slinger is used. The exposed seal is subjected to point pressures which can cause premature leakage or seal breakdown.

The need for adequate drainage of lubricant from the oil seal cavity cannot be overstressed. A good rule to follow wherever possible is to include an adequate cavity with ample drain back holes, sufficient to carry off the maximum flood of lubricant. This insures optimum conditions for the seal with no sacrifice of lubrication.

The engine designer should also consider: (1) an adequate chamfer (30 deg × 1/16 in.) at the leading edge of the bore to aid the OD of the seal during installation, and (2) a suitable chamfer (30 deg × 3/16 in.) on the end of the hub or shaft over which the sealing element must pass. If these chamfers are overlooked or minimized the seal can be cocked or distorted when pressed into the bore, or damaged when passed over the shaft.

Improved

Bus Needs

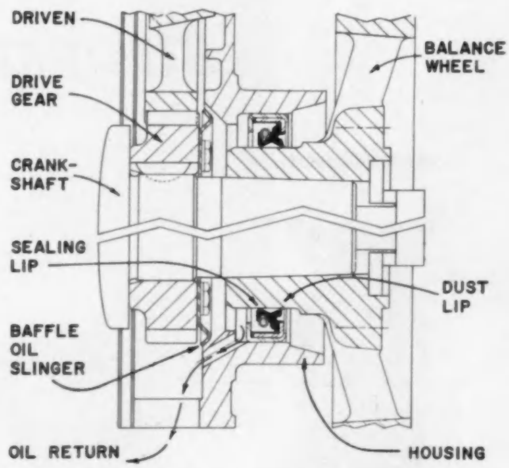

Fig. 1 — Front crankshaft oil seal of polyacrylic rubber, replacing a leather seal in a diesel truck engine, examples the new materials and methods being used in modern seals.

Rear crankshaft oil seals

This example involves the seal in a new V-series of diesel engines. The seal falls in the category of those which ride on the flywheel flange or flywheel flange hub, and require the familiar, completely round, oil seal.

The original seal of leather failed in a 5000-hr life test, but it was a good seal for ordinary use. The new design required a life expectancy of 5000 hr on a shaft running with an estimated 0.018-in. T.I.R. The shaft had a diameter of 4.686–4.687 in. and a hardness of 50–55 Rockwell C, with a 12-microin. finish. The OD of the seal had to be 5.754/5.758 in. The engine speed at full load is 2300 rpm.

The final design of seal is shown in Fig. 2, installed in the flywheel housing. Because of the possibility of dust, a double lip seal was designed. It is basically a silicone rubber sealing element bonded to the outer case. An inner case, depressed at the ID pierced hole, is clinched to the outer case.

In place of the familiar garter spring, a patented retaining ring is fitted over the spring retaining lip. It is made to a calculated contour which contains and confines the back section of the sealing element, allowing for the expected swell of the silicone rubber in the hot engine oil. This construction permits the sealing lip to move with the shaft because the retaining ring always remains concentric with the sealing lip. In this instance it is made of brass but it could be made of stainless steel, zinc-plated steel, copper, and other sheet metals.

The engine builder did not include a slinger as such in this assembly. The timing gears, however, are meshing at a point considerably above the seal, and act as a slinger. There is also a groove around the periphery of the flywheel housing section in which the seal is installed. This groove guides the excess oil around and down to the ample drainback section provided.

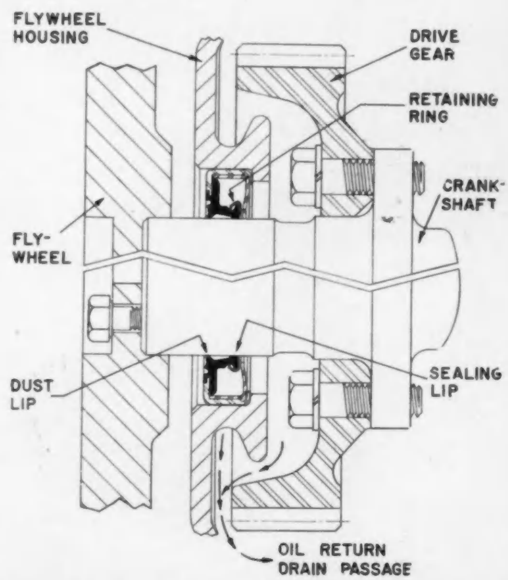

Fig. 2 — Cross-section of rear crankshaft oil seal installed in flywheel housing. Double lip is basically a silicone rubber sealing element. Life expectancy is 5000 hr.

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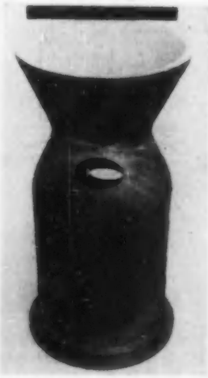
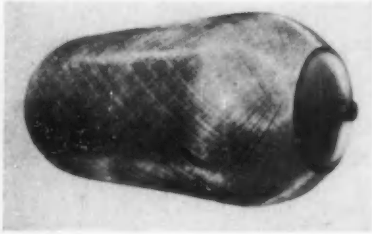
PLASTIC binders strengthen rocket parts

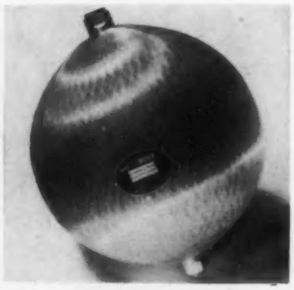


Thrust Chamber

Exit Cone



Cylindrical Rocket Chamber



Spherical Pressure Vessel

Fig. 1
Glass filament rocket chambers and pressure vessels.

Based on report by secretary

E. L. Stone
Boeing Airplane Co.

WHEN SELECTING A MATERIAL for rocket casings or pressure vessels, load-carrying capacity per unit density is the primary consideration. Although plastic materials have relatively low strengths, they may be used as binders in the fabrication of reinforced laminates or composites which demonstrate very high strength-to-density ratios. The reinforcing media in these composites may be paper, canvas, cloth, or for ultra-high strengths, glass filaments. These glass filaments are in the form of bundles of fibers gathered together and twisted to form roving or yarns.

Glass reinforced plastic tankage is fabricated by winding the roving on a solid form and suitably impregnating with a plastic material. This yields, upon curing of the resin, a rigid load-carrying structure. In the fabrication of liquid and solid propellant pressure vessels and cases, there are four principal shapes or configurations: 1. a liquid rocket thrust chamber; 2. rocket nozzle entrance and exit sections; 3. a solid propellant case; 4. a pressure sphere (Fig. 1).

In addition to having an ultimate tensile strength in excess of 250,000 psi, glass filaments have a unidirectional property which makes them highly attractive for pressure vessel construction. These glass filaments can be oriented in directions relative to the direction of principal stress or the direction of resulting stresses. Once the proper orientation of the fibers is determined, based upon internal pressure, external loads, and deflections, the desired di-

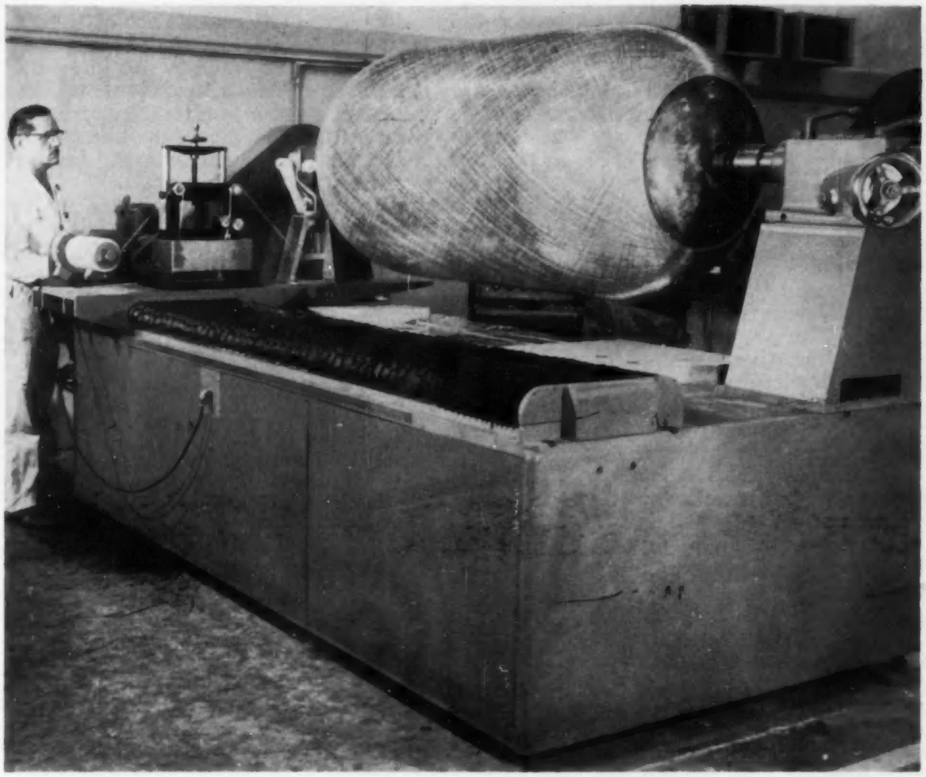


Fig. 2

A cylindrical winding machine for rocket chamber construction.

Fig. 3

Winding a spherical pressure vessel requires that the shape be rotated around an axis while the filaments are wound around the great circle path.

Plastic binders strengthen rockets parts

. . . continued

rection or winding pattern is programmed on the filament winding equipment.

The winding equipment is relatively simple in principle. A cylindrical winding machine is composed of a carriage which discharges the filaments as it travels from one end of the vessel to the other (Fig. 2). This matron is coupled to a rotation of the mandrel such that the desired wrap angle is inscribed. The axis of rotation is automatically indexed for the next wrap so the filaments give a constant coverage rather than superimposing one winding pattern upon another. This programming action is usually produced by cams.

Winding of a spherical shape is very similar to the cylindrical except the shape must be rotated around an axis while the filaments are wound around the great circle path (Fig. 3).

To bind the filaments, a resin is introduced. The conventional technique is to apply the resin coating just prior to the actual winding. The filaments are passed through a tank, separated, and the coating applied. The excess resin is removed by squeezing or wiping and the impregnated filament is wound onto the mandrel. Because the resin is beginning to cure, wrapping time may become critical. For more critically timed operations, a preimpregnated filament or tape may be used. The preimpregnated filaments are separately coated, partially cured, and rewound on spools to be used when required.

Quality control and reliability are assured by check on a programmed basis, the raw materials, in-process inspection, and final acceptance of the finished product.

The raw materials which include the glass filaments are checked for strength, surface finish, and breakage. The resin system is checked for curing time, curing temperature, creep rupture, and shrinkage. These test values are compared to predetermined values of the structural designs.

In-process inspection includes assurance for reproducibility of pattern, winding tension, percentage resin, curing temperature and time, and in-process sampling.

Final inspection or acceptance criteria includes nondestructive hydrotest, hydroburst on a sampling basis and load versus deformation and permanent expansion.

Closures and closure attachments fall into three categories: 1. mechanical attachments such as pins, screws, and rivets; 2. an interference or mechanical type of retention; 3. adhesive bond joints. The joining problems include methods of attachment or removable heads, external flanges, and the attachment of nozzle sections and thrust skirts. When adequate attention is given to the stresses including discontinuities and bending stresses at the closure attachments, numerous methods have been used and demonstrated as satisfactory (Fig. 4).

Dimensional reproducibility of internal volume and weight has been demonstrated for rocket cases. The internal volume and thickness control the weight and strength is reproducible by control of glass filament and resin materials. Any accumulated process variation results in only one dimensional variable, the external diameter or envelope.

Serving on the panel Missile Rocket Case and Pressure Vessel Manufacturing, on which this article is based, in addition to the panel secretary, were: panel chairman **F. H. Matthews**, Boeing; panel co-chairman **W. W. Mills**, Thiokol Chemical; **R. J. Brown, Jr.**, Aerojet-General; **F. W. Allardt**, Douglas Aircraft; and **W. F. Knabb**, Solar Aircraft.

To Order Paper No. SP-329 . . .
. . . on which this article is based, turn to page 6.

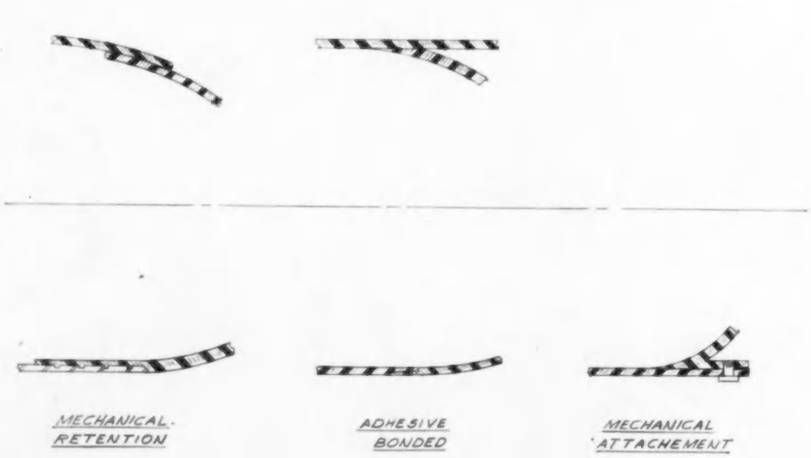


Fig. 4
Head joints in filament wound vessels.

Why Monitor Man-in-Space?

Based on talk by

H. M. HANISH
Litton Industries

(Presented before SAE Southern California Section)

THE SPACE traveler will be monitored to get answers to vital questions:

- Is he alive? If not — why?
- How well is he surviving?
- What is his performance capability now? What trend is indicated with reference to future ability to perform?

We are 1*g* creatures, conditioned to our familiar earth environment for the entire span of our lives; conditioned to a 24-hr daily cycle and a longer 28-day monthly cycle. Each individual cell, every nerve fiber, every blood vessel is, in effect, calibrated to work properly at 1*g*. These calibrations are thrown off, disoriented, in the rapid transition from high *g*'s to weightless state and vice versa. The delicate balance of the human muscular servo system is thrown into confusion during weightlessness. Control errors, overshooting, and extreme hunting can easily develop.

The combination of weightless state, silence, and absence of or severe attenuation of sensory inputs to the astronaut has been shown to produce a psychosis, which in some instances has lasted as long as 24 hr after the test was concluded. Fatigue added to these other factors only hastens the effect.

Multifuel Engines Need Problem Solving

Based on paper by

HANS HOGEMEN
American Bosch Division,
American Bosch Arma Corp.

(Presented before SAE Baltimore Section)

A MULTIFUEL engine should be able to digest Nos. 1 and 2 diesel fuels, compression-ignition fuels (similar to JP-4 fuels) and for emergencies it should be capable of using commercial gasolines of 83–91 octane rating. However, problems arise when the lighter fuels are used.

There is an inherent loss of engine power with the lighter fuels in the approximate relationship of their heat content by volume. Moreover, when the injection pump has to handle low viscosity fuels, fuel leakage into the camshaft compartment increases as the absolute viscosity decreases. This results in dilution of the pump lubricating oil and, unless lube oil in the injection pump is changed frequently, the highly loaded cam and tappet mechanism and camshaft bearings will commence to wear after a comparatively short period of operation, depending to some extent on the plunger size, injection pressure, and fuel temperature.

The smaller and almost negligible leakage of diesel fuels has far less effect on wear due to the inherent lubricity of the fuel itself. Conversely, with gasoline the leakage increases and lubricity is almost totally lacking. To alleviate leakage into the camshaft compartment, special plunger-barrel assemblies are required.

At the moment interest in the multifuel engine is confined almost wholly to the military, which sees in it a means to gain increased mobility and range, but the potential for commercial applications is very large because of possible fuel economies.

To Order Paper No. S221 . . .
on which this article is based, see p. 6.

Brake Design Permits Performance Prediction

Based on paper by

P. F. BLACK
B. F. Goodrich Aviation Products

(Presented before SAE South Bend Division of Chicago Section)

DIRECT actuation of free-floating linings and no self-energization are features of the Hi-torque, multiple-shoe brake which make possible accurate prediction of its performance on earthmovers.

The brake has a T-section ring to provide a flange for attaching the brake to the axle housing or other rigid member. The ring is broken in only one area to provide a channel for the hydraulic connection. This is the torque plate. Over this plate is positioned a full circle, hydraulic expander tube of fabric-reinforced neoprene. Riding directly on the tube are steel plates to which the lining blocks are riveted. The lining has a channel affording a means for inserting a leaf-type retractor spring to insure positive retraction.

To prevent axial movement, the torque plate, expander tube, and lining assemblies are enclosed by side frames, which are bolted rigidly to the torque plate but do not interfere with movement of the linings. Rotational movement of the linings is prevented by welding torque bars between the side frame elements.

Actuation of the expander tube provides a hydraulic platform common to all lining segments, resulting in 360 deg of equal pressure. The toe and heel of the shoe operate under the same pressure on all linings. Absence of any self-energization or mechanical linkages means that no more lining pressure will be exerted on the drum than the hydraulic pressure in the expander tube. Should heat cause the drum to become bell-shaped, the lining will continue to exert uniform pressure since the segments are free to follow any irregularities that develop. As the shoes are free to float, they will seek their own alignment and accordingly the brake assembly may be mounted without the critical alignment required for rigid-shoe-type brakes.

To Order Paper No. S211 . . .
on which this article is based, see p. 6

Aluminum in Cars In World-Wide Rise

Based on talk by

B. R. ALLAN
Canadian British Aluminum Co., Ltd.

(Presented before SAE Ontario Section)

ITALY was top user of aluminum in automobiles in 1958. This metal accounted for 5.5–6.5% of the unladen vehicle weight. France and Germany ranked second with 4–5%, while the U. S. ran a poor third with 1–1.5%.

The use of aluminum in North American motor vehicles rose from 2 lb per vehicle in 1946 to 52 lb in 1959. In the compact car of 1960, the poundage of aluminum will be 80.

European producers have experimented widely with aluminum sheet body panels. The stumbling block to their use appears to be the need to use heavier and less portable welding machines than those used for steel, requiring a change in method of assembly.

Silver Lube Traits of Crankcase Oils Evaluated

Based on paper by

L. O. Bowman and M. W. Savage
California Research Corp.

LOW SILVER corrosion tendencies are desirable in silver-bearing applications operating in the hydrodynamic lubrication region, recent California Research tests indicate. They indicate also that good silver-on-steel friction performance is not required in those applications.

Good silver-on-steel friction performance is required, however, in silver bearings operated in the boundary lubrication region.

The tests which developed these results constituted satisfactory test procedures for measuring the silver corrosion and silver friction characteristics of lubricating oils.

To Order Paper No. 110B . . .
on which this article is based, see p. 6.

Trainer Fuselage Has Detachable Panels

Based on talk by

DAVID D. BLANTON
Javelin Aircraft Co.

(Reported by D. LaMaster, SAE Wichita Section Field Editor)

THE RAWDON T-1, a two-place, fully aerobatic training plane, has its entire fuselage covered with removable metal panels which are attached with Dzus fasteners. This feature makes the airplane particularly well suited for agricultural purposes since the panels can be detached quickly and cleaned to remove corrosive sprays.

The agricultural version of this trainer has a hopper placard load of 800 lb, but it can carry an 1100-lb spray load, and can get off the ground under standard conditions in a run of 600 ft.

Thus far, most trainers have been shipped to South America, equipped with 30-caliber machine gun mounts in each wing, where they have been used for border patrol and training.

Luminometer Evaluation Object of CRC Study

A RECENT two-phase CRC study* was conducted to:

(1) Evaluate the CRC Luminometer as a laboratory method, that is, determined if it was a workable tool and established reproducibility and repeatability using a proposed test technique.

(2) Correlate Luminometer Numbers with full-scale combustion test data on liner temperature and exhaust smoke. The latter was supplied by aviation turbine engine manufacturers.

The conclusions of the first phase include:

(1) Standard deviations for repeatability and reproducibility increase with Luminometer Number.

(2) For fuels of approximately 50 Luminometer Number, the average (pooled) repeatability standard deviation was 2.6 Luminometer Numbers and the reproducibility standard deviation was 2.8 Luminometer Numbers.

(3) Repeatability was affected by variations in atmospheric conditions, particularly borametric pressure and humidity. Limited data indicate the standard deviations can be reduced by approximately 50% if barometric pressure can be held constant or if pressure corrections are applied; correcting for humidity changes also is expected to reduce the standard deviations further.

The second phase consisted of the correlation of data supplied by aviation turbine engine manufacturers and others on three combustors. On the basis of this limited data the Luminometer Numbers show a correlation with liner temperature and exhaust smoke.

CRC 336 recommends that:

More tests be made on fuels having higher than 100 Luminometer Number to establish more firmly the reproducibility and repeatability of the test in this range.

A program be conducted to determine more precisely the effect of variations in atmospheric conditions upon Luminometer Number, and to develop a correction method for these variations.

To Order CRC No. 336 . . . on which this article is based, see p. 6.

* See CRC Report 336, Evaluation of CRC Luminometer.

Licking Surge Ills In High-Speed Fueling

Based on paper by

RALPH H. K. CRAMER and DONALD L. DAVIS
United Air Lines, Inc.

EQUIPMENT for high-speed pressure fueling of jets must be made an integral part of the fueling system since it is the compatibility of equipment with aircraft that insures safe, fast refueling.

Tests carried out by United Air Lines with a Douglas DC-8 have revealed the probable causes of surges to be as follows:

A. Startup surge:

Air in the manifold will allow an initial acceleration of fuel. The rapid deceleration caused when the air in the manifold is compressed in effect acts as a rapidly closing valve. Startup surges produced when there is no air in the manifold may be attributed to control valve or pump output characteristics.

B. Back-flow surge (one fueler supplying fuel through the aircraft fuel manifold into opposite fueler):

This is a major source of surge. Although the fuel velocity is rather low, the mass is great and the valve closing time approaches zero. The fill nozzle check valve, installed to prevent backflow should a hose rupture, is of the poppet type and closes very fast to cause this type of surge.

C. Fill valve shutoff induced surges:

These surges appear to follow expected theoretical values, which are a function of mass, velocity, and time. A fuel system designed and maintained within the proper values will suffer no irregularity from this condition.

Recommendations Based on Tests

Before these tests were concluded, Douglas was able to release to the airlines using DC-8's, parameters covering fueling equipment to prevent damage to aircraft during fueling. These measures included:

1. Fueler valve initial opening time to eliminate startup surge.
2. Fueler valve sensing time to eliminate rapid surge during aircraft fill-valve shutdown conditions.
3. Fueler valve pressure control tolerances to insure stable pressure delivery to the aircraft during single- or dual-point fueling.
4. Fueler maintenance and inspection procedures to insure unit is functioning as designed.

Douglas also has been able to observe undesirable fueling conditions as a result of these tests. They might be eliminated effectively by minor changes in the fuel system. These include:

1. Anti backflow fill fittings.
2. Manifold relief valves.
3. Structural support of various pieces of the fueling manifold.

Current tests will determine which of these should be incorporated in the fueling system.

To Order Paper No. 139A . . . on which this article is based, see p. 6.

Basic VW Design Changed in Detail

Based on talk by

GUENTHER E. POHL
Volkswagenwerk, GmbH

(Reported by Dan B. Kuiper, SAE Western Michigan Section Field Editor)

MAGNESIUM is now used for the Volkswagon crankcase to reduce the machining time formerly required with aluminum. It also reduces weight to aid in minimizing oversteer. Cylinder heads are aluminum rather than magnesium because of high combustion chamber temperatures. The cylinders are cast iron with phosphorus to improve lubricity. VW engines are expected to operate for 70,000 miles.

Speed of the blower has been lowered to reduce the noise level. Air is introduced to the plenum chamber at 17.5 cfs at 3400 rpm.

When first introduced, the Volkswagon gears were not synchronized. Now approximately 90% of the cars use a 4-speed gearbox with three speeds synchronized. On the truck model all gears are synchronized.

At curb weight there is a noticeable camber and toe-in with the independent swung axle which is reduced as the rear axle is loaded. The camber was reduced in 1958 and again in 1959. In 1959, torsion bars were introduced to prevent excessive oversteer and hangover.

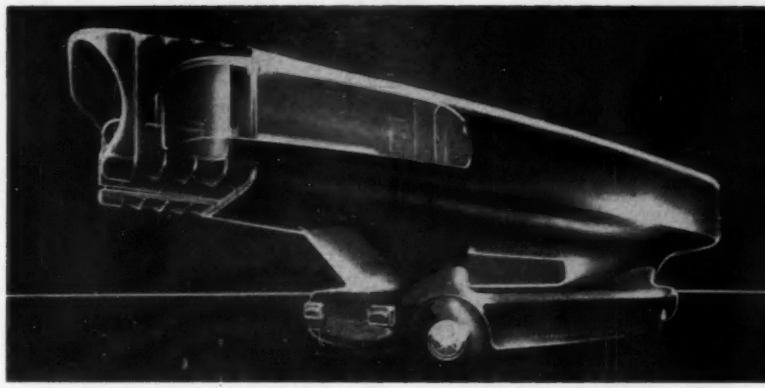
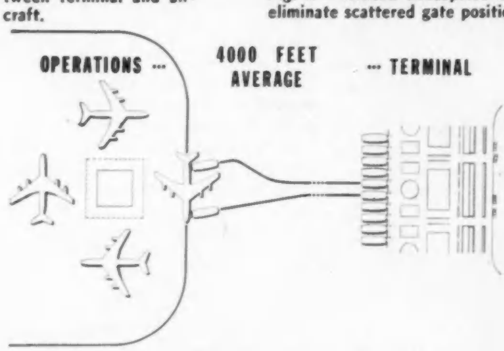


Fig. 2 — Artist's conception of the mobile lounge, a waiting room on wheels. The vehicle will eliminate scattered gate positions and spare passengers long walks and stair climbing.

Fig. 1 — Passengers at the Dulles International Airport will be "packaged" in mobile lounges for transportation between terminal and aircraft.



Mobile Lounge New Airport Feature

Based on paper by

HERBERT H. HOWELL, Federal Aviation Agency

(Presented before SAE Washington Section)

A MOBILE lounge, a vehicle serving as a lounge for emplaning passengers and capable of transporting them to aircraft parked at some distance from the terminal, is planned for Dulles International Airport, serving the Nation's capitol (Fig. 1).

Realizing that an orthodox terminal building with fingers to provide 90 gate positions would require passengers to walk intolerable distances, designers have come up with the idea of a mobile lounge. It permits great flexibility in terminal facilities design, it will cut walking to a minimum, eliminate stair climbing, and keep passengers out of inclement weather.

Plans call for a vehicle about 60 ft long and 15 ft wide to seat upwards of 90 passengers. An artist's rendering of its design is shown in Fig. 2. Contract for design and production of a prototype vehicle has been given the Chrysler Corp. in association with the Budd Co. and industrial designer, Walter Dorwin Teague.

To Order Paper No. S216 . . .
on which this article is based, see p. 6.

Four-Step Guide to Better Dimension Control

Based on report by secretary

William Gray

North American Aviation, Inc.

VARIATIONS in chemical composition, amount of cold work, annealing temperatures austenite conditioning temperatures, cooling rates, and refrigeration temperatures can alter the amount of transformation and affect dimensions of a finished part. Control of the various steps in the fabrication of detail parts is important to insure that conditions are proper for final heat treatment and that correct finished dimensions are obtained.

Good processing operations during fabrication include:

1. Location of holes in stamped or machined parts should only be done after final heat treatment to provide close tolerance and prevent stresses due to mismatch in assembly.

2. Parts fabricated by drop hammer, hydro press, stretch or brake forming techniques should be finished to final size after transformation and prior to aging. If severe working has occurred which would influence the final dimensional accuracy, re-annealing should be accomplished prior to transformation.

3. All detail parts assembled for brazing should be in the same condition for ideal operation. Detail parts should be solution annealed after severe or non-uniform forming to assure control or the uniformity of dimensions in the finished panel.

4. Control of welding operations is essential since change in chemical composition in the weld area produces a different transformation than in adjacent areas and local distortion can occur. A solution anneal after welding and prior to austenite conditioning is usually recommended to insure more uniform transformation.

Serving on the panel Material and Processing Controls and Modern Alloys, in addition to the panel secretary, were: chairman **C. T. Aubrey,** North American Aviation, Inc.; co-chairman **Hugh Rush,** Rohr Aircraft Crop.; **C. B. Smith,** Douglas Aircraft Co., Inc.; **D. L. Walker,** Convair Div., General Dynamics Corp.; **G. B. Pritchett,** Solar Aircraft Co.; **J. W. Baer,** Ryan Aeronautical Co.; **J. P. Anderson,** North American Aviation, Inc.; **G. Bennett,** Douglas Aircraft Co., Inc.

To Order SP-329 . . .
on which this article is based, see p. 6.

OIL Make-up Affects Octane-Need Increase More as Ratios Rise

Based on paper by

L. D. LaCroix and M. L. Kalinowski

Standard Oil Co. (Ind.)

OCTANE-REQUIREMENT INCREASE is affected more by motor oil differences as compression ratios rise, according to recent tests on seven commercial 10W-30 oils. The tests were unusual in that a single deposit-accumulation cycle was used to show the effects of motor oil composition on surface ignition and corresponding octane-requirement increase, rumble, and spark-plug fouling. This laboratory procedure was developed with a production-model V-8 engine, cycled to simulate city driving for 200 hr.

Other results from this single-procedure test indicate that:

- Surface ignition, rumble, and spark-plug fouling are alleviated by phosphorus in motor oil additives.
- A threshold concentration of about 0.1% phosphorus appears necessary for effective control of surface ignition and rumble; amounts as low as 0.05% reduce spark-plug fouling.
- In future engines with higher compression ratios, careful selection of motor oil components should contribute even more to combustion control.

How Phosphorus Helps

The beneficial effects of phosphorus in meeting the needs of octane-requirement increase are illustrated by several specific test results.

Oil A, for example, which contained more phosphorus than any of the other three oils tested, gave the lowest relative count rate and required requirements to 96 octane number. Oils with little or no phosphorus brought the requirements only to the 100-octane level. Oil B controlled requirement to the same level, but showed poorer control of count rate. The minimum concentration of about 0.1% phosphorus to obtain appreciable reduction in surface-ignition requirement agrees with the figure established in engines of lower compression ratio. From this it can be seen that phosphorus in motor oils parallels the action of phosphorus in fuels in reducing surface ignition.

Motor oils that lower octane requirement add to the number of cars that are satisfied with octane number at a given level. The extent of this increase in car satisfaction can be calculated from nationwide surveys of octane requirements determined in cars operating on a cross-section of present-day motor oils. When this is done, it shows that a representative regular-grade fuel of 93 Research octane number, together with an average motor oil, satisfied 75% of all the cars on the road in 1958. Changing to an oil that lowers octane requirement one unit would have raised the level of satisfaction to 80%. With premium fuel of 99 Research octane number, satisfaction would have risen from 85% to 90%, with the same change to the low-ORI oil. This improvement is equivalent in effect to upgrading each fuel one octane number.

As compression ratios go higher, careful selection of oil components should contribute even more to combustion control.

Table 1 — Effects of Phosphorus in Reducing Surface Ignition

Oil	Phosphorus, %	Relative Count Rate	Surface-Ignition Requirement
Base oil	0.0	170	100
C	0.05	310	100
F	0.09	170	98
B	0.13	155	96
A	0.19	100	96

To Order Paper No. 126U . . . on which this article is based, see p. 6.

Getting the Most Out of Diesel Engines

Based on talk by

FRANK SINKS

Detroit Diesel Engine Division, General Motors Corp.

(Presented before SAE St. Louis Section)

DIESEL-engine performance in the installation can be improved by design considerations for temperature and cleanliness. Power loss can be appreciably reduced by selecting tank and filter locations remote from exhaust or cooling fan heat. Proper design and location of the tank filler will help greatly to keep fuel clean.

Air temperature can affect engine power. Air inlet locations should be such as to provide the coolest possible air. Change in air density can come from restriction as well as temperature, therefore, selection of air cleaners and inlet piping is an important consideration.

Muffler and exhaust piping need to be analyzed if power losses are to be held to a minimum. Power loss due to back pressure can become excessive.

Parasitic losses must be watched. The fan is the principal offender. In a good installation, fan power should be less than 6% of the gross engine power. As the load factor is reduced, the developed horsepower absorbed by the fan is increased proportionately and can run as high as 11% at half throttle. Variable-speed fans have proved their worth in fuel saving.

Specs Serve Three Functions

Based on report by secretary

Bruce A. Engman

Ryan Aeronautical Co.

SPECIFICATIONS serve three distinct functions in prime contractor—subcontractor dealings:

Legally — A specification provides a clear understanding of the requirements of the procuring prime contractor to be accomplished by a subcontractor.

Technically — A specification provides a definition in clear common trade terminology of the product or service to be provided.

Administratively — A specification provides a definition of the degree of surveillance to be exercised by the prime contractor and the data . . . management and technical . . . to be provided by the subcontractor.

Serving on the panel Communication Between Vendor and Prime Contractor, in addition to the panel secretary, were: chairman **R. G. Sharp,** Ryan Aeronautical Co.; **Harold Raiklen,** North American Aviation, Inc.; **R. H. Gilliland,** Convair Division, General Dynamics Corp.; **R. H. Kemp,** North American Aviation, Inc.; **D. H. Painter,** Convair Division, General Dynamics Corp.; **John Fitzpatrick,** Whittaker Controls.

6 Inspection Methods Catch Honeycomb Faults

Based on report by secretary

W. F. ROBERTS

Norair — Northrop

THE three basic nondestructive inspection methods for brazed honeycomb sandwich at present are:

1. Film radiography.
2. Fluoroscopy.
3. Ultrasonics.

Three additional nondestructive techniques being investigated at this time are:

1. Thermographic methods.
2. Zinc hot-shot testing.
3. Radioisotopes.

Film radiography can show the size of the fillets between the core and face sheets on both sides of the panel, amount of node flow, position of edge or auxiliary members, and amount of core crushing. It also provides a permanent record of the panel condition.

Fluoroscopy essentially provides the same information as film radiography,

continued on p. 132

SAE NEWS

Delmar G. Roos

DELMAR G. ROOS, president of SAE in 1934, was on a business trip concerned with the consulting practice he had been engaged in since retirement from Willys-Overland, Inc., when he died of a heart attack on February 13, 1960.

Universally called "Barney," Roos was one of the best known and most dynamic figures in the automotive engineering world. Last fall he wrote for SAE Journal an article about the Russian cars when first they were displayed in the United States. In preparing it, he cut through barriers of unwilling USSR cooperation to get the facts — with the same vigor of attack and brilliance of insight that had characterized his career ever since he joined Locomobile back in 1912. He joined SAE in that same year.

A long record of constructive executive and engineering achievement marks the imprint which Roos left on every group with which he was associated — and every engineering problem to which his penetrating mind applied itself.

Roos became vice president and chief engineer of Locomobile, and served 13 years with that pioneer fine-car maker. Then he became chief engineer of Marmon Motor Car Co. for a brief period before joining Studebaker. There he was to lead the development of an entirely new line of cars for that oldest car manufacturer. Development and adoption of Studebaker's first straight-eight was included in this period.

Then, following a year or two as consultant for the Rootes group in England, Roos became vice president of engineering of Willys-Overland . . . and there led development, design, and testing-to-Army-satisfaction of the famous Jeep of World War II.

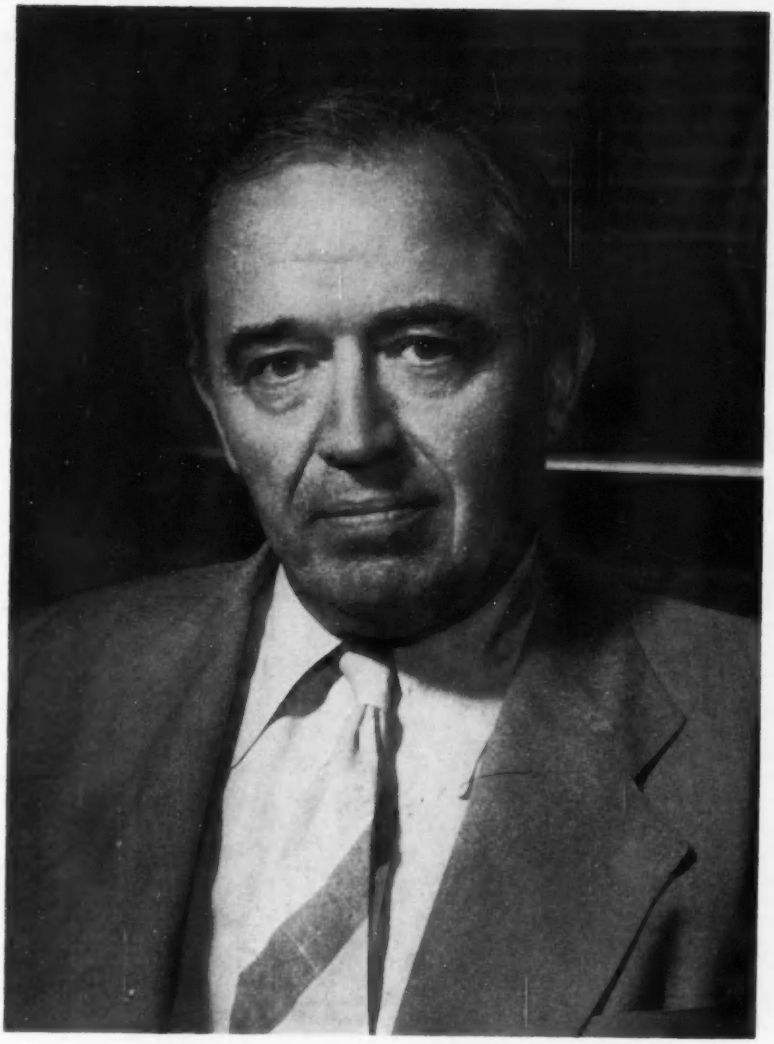
He continued to be an articulate advocate of what are now being called "compact" cars in the era when industry was moving to ever larger and heavier designs. He lived to see a trend developing in the direction of his engineering thinking.

Roos contributed major stimulation to the thinking and development of hundreds of engineers throughout the industry. Every one who ever participated in a Roos discussion came away with his mind stirred from lethargy; his thought aroused to new concepts. Roos cut through sham wherever he met it; drove through, over, and around obstacles as necessary to achieve sound engineering results.

Near the end of 1953, he set up an office as technical consultant, upon his retirement from Willys-Overland. In that work, he continued to be very active, both as an engineering consultant and general advisor to a number of companies. He was a director of several of the organizations which he served, including Formsprag Co. of Detroit.

Roos had an eager interest in almost every area of human activity. He was a brilliant conversationalist on topics of art, drama, and economics — as well as engineering and science. He took an active interest in politics; once served as a County Councilman in St. Joseph's County, Ind. He was an excellent athlete . . . was a member of the fencing team while an undergraduate at Cornell — where he got his M.E. in 1911 . . . and he continued to be an active tennis player throughout his life.

Roos was a fighter for what he believed in, an inspiration to all with whom he talked and worked, and one of the great engineers of the automobile industry.



Delmar G. Roos
1887-1960

Journal Listings Get Jobs for Students

THE 176 SAE Enrolled Students who listed their after-graduation job desires in the January SAE Journal got a total of 513 responses from 50 different companies. One man heard from 15 different companies; 87% of the 176 got one or more responses. Responses are still filtering in.

Returns are not all in from the listing of 85 SAE Enrolled Students, looking for summer jobs in 1960, which appeared in the February SAE Journal. Early returns indicate, however, that the response will be substantial.

This use of SAE Journal pages to help SAE Enrolled Students to desirable after-college connections resulted from the joint efforts of the SAE Placement Committee and the SAE Student Committee. Placement Committee chairman in 1959, when the project was started, was J. H. Dittfach. 1960 Placement Committee Chairman T. M. Dunn reports the Committee's satisfaction with the results of the listing is so great as to insure its repetition for another year. E. P. White, chairman of the Student Committee last year, carries on in 1960 as chairman of the Sections Board's Student Activities Committee. He has also expressed high satisfaction with the results on behalf of his Committee.

T. M. Dunn

Following the January listings, reprints were made of the six SAE Journal pages which carried them . . . and an additional mailing was made to the 1000 companies with which the SAE Placement service is regularly in contact.

Bachman Honored at End of Treasurership; Delaney 10th to Serve

B. B. BACHMAN, who served as SAE Treasurer from 1943 through 1959 after being the Society's President in 1922, was honored recently by the 14 living SAE Past-Presidents under whom he served as Treasurer.

On February 18, George Delaney, 1960 Treasurer, presented to Bachman on behalf of those Past Presidents an elaborately embossed scroll, encased in a tooled-leather portfolio, expressing to Bachman appreciation "for the talented services which you have, with notable generosity, continued to render through many years." The appreciation, signed by each of the 14 living Past-Presidents, went on to say in part:

"All of us are grateful for your devotion as we are gratified by the significant yield from your effort.

"Deeply do we appreciate that every phase of the Society's advancement has profited from the wisdom of your quiet leadership. We recognize your career of constant understanding, sympathy, and helpfulness as a precious example and precept for those who live to serve."

Succeeding Bachman as Treasurer for 1960, Delaney is the tenth man to serve as Treasurer in the 55 years of the Society's existence.

Since the Society's start, the stated term of the Treasurer has been for one year — but all SAE Constitutions have provided that he might be elected to succeed himself.

First Treasurer of the Society was E. T. Birdsall, a consulting engineer, who served as both Secretary and Treasurer from 1905 through 1907. (Henry Ford was First Vice-President in each of these three years . . . and A. L. Riker was President.)

In 1907, Birdsall moved his business to Detroit — and the office of the Society went with him. Then, according to the 25th Anniversary Issue of SAE Journal (June, 1930) "lack of cohesion between the Secretary's office and the other officers, augmented by the long distance between the respective offices, left the Society in a much disorganized condition."

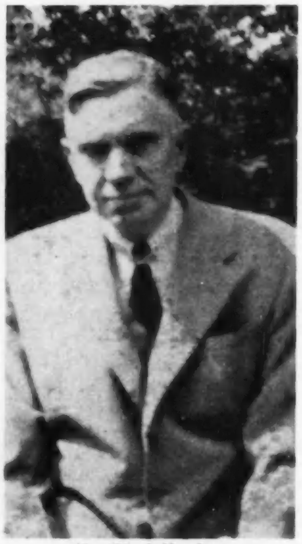
By 1910, Coker Clarkson had joined the staff as the Society's first full-time paid Secretary . . . and his first act upon assuming his new post was to collect "what scattered records of the Society were then in existence" and

Van Wyck Hewlett Receives 50-year Membership Certificate

VAN WYCK HEWLETT was an honor guest at Metropolitan Section's January meeting where he was presented with a certificate for 50 years of membership in the Society.

He applied for SAE membership before receiving his M.E. degree from Polytechnic Institute of Brooklyn. Following his graduation, he had long and varied experience in the automotive industry.

He designed the first of a series of single cylinder motorcycles while with the Indian Motorcycle Co.; was instrumental in the design of two models of aircooled-engine automobiles; worked on the design of a vacuum street sweeper; was chief engineer of a small concern that made rotary tilling machines; developed a test engine to try out a patented rotary valve; and did engineering work on two light-weight railway trains — the Talgo and the Train X.



Van Wyck Hewlett

During World War I, he worked on airplane and engine design; and in World War II, he checked glider and airplane drawings and was in charge of engine installations.

It was during 1930 that he wrote several articles on diesel engines and their applications in the automotive field . . . three of them for Diesel Power.

Early in 1949, he joined Grumman Aircraft Corp. as tool engineer, where he remained until his retirement in 1958. While with Grumman, he helped to organize an old car club. He was historian for this group and wrote two papers on the subject.

Right now, his hobby is old cars — and since 1950 he has been a patron of Austin Clark's Long Island Automotive Museum. Over the years, he has collected considerable information on the early cars, going as far back as 1900.

(Others who became 50-year members in 1959 were: Alfred P. Sloan, Jr., George C. McMullen, Herbert Chase, Fred I. Tone, and T. P. Chase. See SAE Journal, January, 1960)

to take "possession of the bank account which then approximated $250."

In that year A. H. Whiting, vice-president of Whiting Motor Co. of New York, became Treasurer — and served through 1911. Then H. F. Cuntz, a mechanical engineer and patent attorney, was elected and served from 1912 through 1914. A. B. Cumner, manager of Federal Truck Co., of New York City, served in 1915.

Then Herbert Chase, the Society's Assistant Secretary, (who received a 50-year membership certificate early this year) became Treasurer in 1916 and was re-elected to serve in 1917.

B. B. Bachman

C. B. Whittelsey, president of Hartford Rubber Works Co. at the time of his election, served as Treasurer from 1918 through 1930. C. W. Spicer, who was to become President of SAE in 1938, was the next Treasurer. He served from 1931 through 1933.

From then on, SAE Treasurers have been Past-Presidents of the Society. David Beecroft (President in 1921) served as Treasurer from 1934 to the time of his death in 1943. Since that time, B. B. Bachman has been Treasurer through 1959.

Meetings-Announcement Costs Biggest Section Budget Item

by George J. Liddell, chairman,
Section Finance Committee,
SAE Sections Board

COST OF MEETINGS ANNOUNCEMENTS is the largest single expense item for most SAE Sections, a recent study by Section Finance Committee of the Sections Board reveals. One-fourth of the Sections and Groups spend more than $2 per member — over half of the dues income they receive from the Society — for announcements. Seven of the 34 Sections and Groups reporting actually spend *more* than the $4 per member made available by the Society. This means, of course, that all other expenses are being met from other locally-produced income sources.

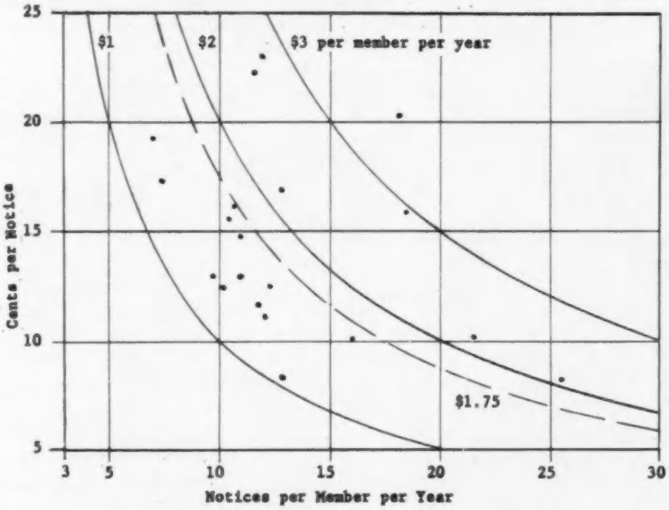
The Sections and Groups which spend more than $2 per member, the survey shows, sent more than 18 notices per member per year . . . or spent more than 16¢ per notice . . . or both.

The accompanying chart shows the relationship between the amounts spent per notice, the cost per member per year, and the number of notices per member per year. The data are based on responses from 34 of SAE's 46 Sections and Groups.

The high cost per member in some instances results from many more notices having been sent to non-members than to members. In other instances elaborate formats pushed unit costs up.

The high proportion of total expense which meetings announcements represent make this item the logical first point of attack for Sections seeking routes toward more economical operation, the Section Finance Committee believes. Conditions and requirements differ so greatly from Section to Section that no overall cost standard can properly be envisioned. But study of the data revealed by this study and the accompanying chart may well help individual Sections in their attempts to lower overall costs. Involved, obviously, are Governing Board policies as regards number and character of meetings . . . and as regards the value of using relatively expensive meetings announcements as a monthly direct-mail piece for membership promotion. Then, too, the format and production methods used in getting out the notices themselves are always a factor.

Cost of Sections Meetings Announcements



Cost Is Unit Price Times Quantity

This chart demonstrates the choices open to Sections. Some choose to send a relatively few expensive notices; others send many more, but not such costly ones, for the same money.

2 Sub-groups Active In Powerplant Activity

THE POWERPLANT ACTIVITY COMMITTEE — newly named and expanded successor to the old Diesel Engine Activity Committee — has already generated two active subcommittees in its first months as an agency of the SAE Engineering Activity Board.

The Small Industrial and Marine Engine Subcommittee has already set up 11 specific areas of technical interest for exploration, ranging all the way from lightweight engine design to new concepts in cam design. The other new subcommittee, aimed at development of technical information for SAE members in the gas turbine area, has also hit upon 11 areas for specific development. These Gas Turbine Committee areas range from the general area of material for gas turbines all the way to manufacturing procedures and test procedures.

Powerplant Activity Committee Chairman F. A. Robbins reports that J. H. Horton, of Ft. Belvoir, is heading up the small Industrial and Marine Engine Subcommittee, while W. A. Turunen of GM Research is chairman of the Gas Turbine Subcommittee.

SAE Letters from Readers

From:
P. H. Schweitzer (M '23)
Schweitzer & Hussmann
P. O. Box 557
State College, Pa.

Dear Editor:

The following method of plotting power performance test results is not new, but it has not yet found the wide use it deserves.

It presents engineering performance in a picturesque manner easy to grasp and interpret. We have also found it catches erroneous readings or arithmetic errors that would slip by, when conventional plotting is used.

The Method Explained

The results of constant-speed, variable-load tests are variously plotted over abscissas representing bhp, or bmep, or pound of fuel per hour or per minute or cu mm fuel per stroke and some other ways. A very convenient and most instructive way to plot such test results for a diesel engine is by plotting the bmep against an abscissa called input mep.

Input mep is defined as the mep equivalent of the energy input. It is expressed in psi. The energy input is the energy of the fuel burned and is often expressed in Btu per min, or lb of fuel per hr or cu mm fuel per stroke, etc. There are simple relations between all these quantities and any of them can be converted into input mep, which is the preferred abscissa scale:

$$\text{Input mep} = \frac{\text{work}}{\text{displacement}} = \frac{\text{lb-in.}}{\text{in.}^3}$$

$$= \frac{12\ \text{lb-ft}}{\text{in.}^3} = 9350\,\frac{\text{Btu}}{\text{in.}^3}$$

$$= \frac{9350}{V_{disp}} \times \frac{\text{Btu}}{\text{cycle}} = 9350\,\frac{h_f}{V_{disp}} \times \frac{\text{lb fuel}}{\text{cycle}}$$

and, since 1 lb fuel $= 454{,}600/\gamma$ mm^3:

$$\text{input mep} = 0.0206\,\frac{h_f\gamma}{V_{disp}} \times \frac{\text{mm}^3\ \text{fuel}}{\text{cycle}}$$

Because of these relations, the mean effective pressure may be plotted against any of these quantities indicative of the load. However, plotting it against the input mep has particular advantages, as will be seen from a concrete example, shown in Fig. 1.

The engine to which the plot refers is a 2-cyl $4\frac{1}{4} \times 5\frac{1}{2}$-in. 2-stroke-cycle diesel engine, having 78 cu in. displacement. The test was run at 2000 rpm on combat gasoline MIL-G-3056A with a specific gravity of 0.708 and a net heat value of 18,500 Btu per lb. With these values input mep is:

222×10^4 lb/cycle or 3.45 cu mm/cycle

The main abscissa scale is input mep as defined above and the main ordinate is bmep. But by extending the bmep curve with a straight line, its intersection of the vertical ordinate below 0 bmep gives the friction mep. By transposing the zero point to this intersection the ordinates represent imep instead of bmep.

This mep plot alone shows much more than conventional plots. It can be compared directly with mep curves obtained at other speeds, with other engines, with other fuels and other lubricants. The mep curve has three qualities; height, steepness, and straightness. The height is determined by the friction. The smaller the friction mep the higher the point of origin.

The steepness is determined by the cycle efficiency. The higher the cycle efficiency, the steeper the mep line.

At higher load the mep curve bends down. This is caused mainly by incomplete combustion when the fuel input increases and the excess air decreases. The better the combustion at increasing load, the straighter the mep curve. A better spray, for instance, will prevent the curve from bending down so soon. Even at a glance the mep curve permits a fair judgment of the excellence of the engine.

The lower part of the mep curve is a straight line with about 45-deg slope if the mep scale is double the input mep scale. This corresponds to an indicated efficiency of 50%, which is about typical for a good diesel engine. It has been observed that when the tangent to the mep curve falls to 20 deg the exhaust becomes unclear. Arbitrarily this point has been selected as the rating point and designated with RR relative rating. No matter how arbitrary this point is, at least on the same engine the higher the RR point the better the performance of the engine.

From this plot also the indicated and brake efficiencies can easily be read:

imep/input mep = indicated efficiency
bmep/input mep = brake efficiency

They are plotted with a scale on the right-hand side. The specific fuel consumption is, of course:

$$\text{isfc} = \frac{2545}{h_f\eta_i} \qquad \text{bsfc} = \frac{2545}{h_f\eta_b}$$

For gasoline:

$$\text{isfc} = \frac{0.137}{\eta_i} \qquad \text{bsfc} = \frac{0.137}{\eta_b}$$

which could also easily be plotted on the same graph but were omitted for the sake of clarity.

The part of the plot which refers to the brake values is correct without any reservation. However, in the determination of the imep and of the indicated efficiency, two assumptions are being used:

1. The friction mep is independent of the load.
2. At very light loads (say less than

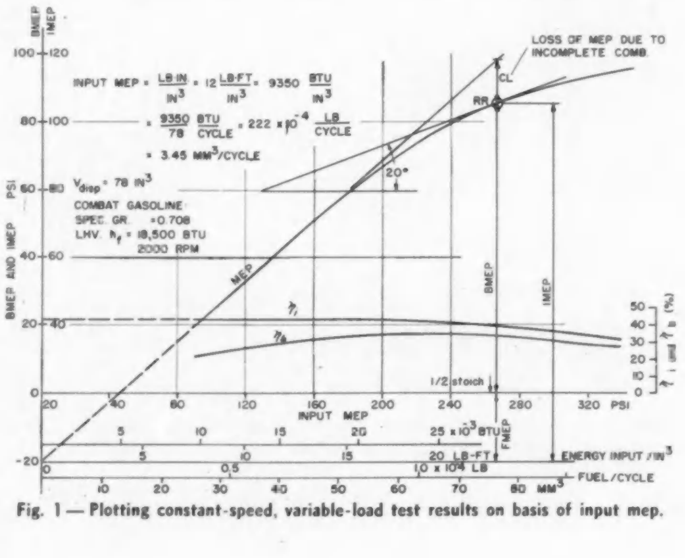


Fig. 1 — Plotting constant-speed, variable-load test results on basis of input mep.

20-psi bmep) the indicated efficiency of the engine is constant, independent of load.

The first assumption is a close approximation, which is accepted every time we determine the friction mep by motoring. The second assumption is true to a great extent for diesel engines but not at all for spark-ignition engines. The reason for this is that, at very high air-fuel ratios (diesel idling) the combustion efficiency is practically 100% and the cycle efficiency is determined largely by the compression ratio. This assumption is the basis for the drawing of the "Willans line," frequently used with other abscissas for the determination of the friction mep.

If the measured mep points do not go down far enough to allow a straight line extrapolation or the friction mep is ascertained accurately by the hot motoring method or other means, the so determined friction mep may be placed on the ordinate scale and the lower end of the mep curve be connected with it. We then can proceed to determine the brake efficiency or bsfc.

In addition to the input mep (psi) the abscissa of the graph shows four more scales: lb-ft per cu in., Btu-cu in., lb of fuel per stroke, and cu mm fuel per stroke. All these are interrelated by the equations cited and if any one of these quantities is known, it can be converted into input mep, which allows efficiency determinations simply by dividing the ordinate by the abscissa.

Another point marked on the abscissa scale is "½ stoich." This point corresponds to a theoretical air-fuel ratio of 2.0 by assuming that the cylinder contains one displacement volume of pure air. In this instance this location of point differs little from the RR point.

All of this is not very new. Fuel per hour of fuel per cycle has frequently been used for performance plots and the Willans line was often drawn for friction mep detemination in such plots. Cramer and Froehlich gave a paper in 1956 (ASME 50-OGP-8 entitled, "Rating Engines by Fuel-Air Ratio Aspects") in which they plotted the bmep against specific input:

$$I = \frac{HF}{DN}$$

where F is the fuel rate (lb per min), D is the piston displament, N is the number of cycles (half rpm in a 4-stroke engine), and H a conversion factor (in.-lb per lb fuel $= 778 \times 12 \times h_f$. I is really nothing else than our input mep and the Cramer and Froehlich plotting can be used for every purpose described above.

Hans L. Wittek in his SAE paper, "Development of Two New Allis-Chalmers Diesel Engines," uses in his Fig. 13 the same type of plotting and credits the method to C. B. Dicksee. The only difference is that the abscissa in the Wittek-Dicksee plot is "energy input" (ft-lb per in.^{3}) This is just 1/12th of the input mep and by the use of that factor allows similar determination of indicated and brake efficiencies.

From:

A. F. Dewsberry
Engine Section, Construction Equipment Division
International Harvester Co.
Melrose Park, Ill.

Dear Editor:

The January, 1960, edition of SAE Journal carries an adaptation on pages 42–45 of a recent paper which I co-authored with C. P. Bozos and J. B. Reeves, Jr.

Fig. 1 at the top of page 43 shows what is captioned as a carbureted engine. This is an unfortunate mis-labeling, since this is actually a view of one of the diesel engines described in the article as installed in a "cab-forward" truck and is clearly so described in the paper, 116T.

OUR MISTAKE! The picture on the right below was incorrectly labeled when it appeared on page 43 of the January SAE Journal . . . where it was part of Fig. 1 of the article "New Diesel Designs Geared to Manufacturing Economies" by IHC engineers A. F. Dewsberry, C. P. Bozos, and J. B. Reeves, Jr. . . . . Below is the caption as it should have read:

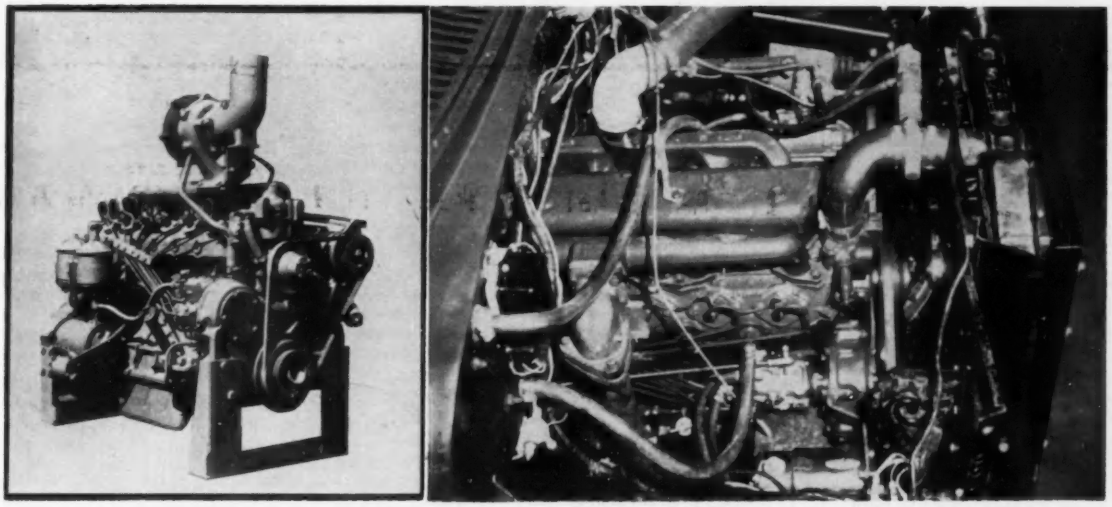


Fig. 1 — New IHC DT-282 turbocharged diesel (left), and (right) another member of IHC's new diesel family, the D-301, as installed in a highway truck.

SAE National Meetings

- **March 22–24**
  National Production Meeting, Statler Hotel, Cleveland, Ohio
- **April 5–8**
  National Aeronautic Meeting (including production forum and engineering display), Hotel Commodore, New York, N. Y.
- **June 5–10**
  Summer Meeting, Edgewater Beach Hotel, Chicago, Ill.
- **August 16–19**
  National West Coast Meeting, Jack Tar Hotel, San Francisco, Calif.
- **September 12–15**
  National Farm, Construction and Industrial Machinery Meeting (including production forum and engineering display), Milwaukee Auditorium, Milwaukee, Wis.
- **October 10–14**
  National Aeronautic Meeting (including manufacturing forum and engineering display), The Ambassador, Los Angeles, Calif.
- **October 25–27**
  National Transportation Meeting, Hotel Leamington, Minneapolis, Minn.
- **October 31–November 2**
  National Powerplant Meeting, Hotel Cleveland, Cleveland, Ohio
- **November 3–4**
  National Fuels and Lubricants Meeting, The Mayo, Tulsa, Okla.

EUROPE is Advancing Rapidly

By Leonard Raymond, 1959 SAE President

During an extensive European trip last Fall, as President of SAE, Raymond met with nine European technical societies in six countries . . . visited 17 automotive plants and six laboratories in seven countries . . . and was the guest at numerous luncheons, dinners, and receptions.

This was the first visit in 40 years by an SAE president to Europe during his term of office in his official capacity. Returning, Raymond reported to the SAE Past Presidents Advisory Committee and to his 1959 Council:

"The reception was somewhat overwhelming, because of the tremendous prestige of SAE, some of which rubbed off on its president."

THIS WAS my fifth trip to Europe since my first visit in 1955. The reasons for my visits with technical societies were:

- To bring to them SAE's greetings and felicitations;
- To encourage interchange of technical information among engineers of different countries;
- To show, through the examples used in the paper which I delivered, how our American system of voluntary cooperation on problems of mutual interest has accelerated technical progress, with major technical and economic benefits.

Conversely, it was brought home to me that FISITA, the overall European automotive engineering society and some of its key members — particularly the French SIA — are eager to promote closer cooperation between SAE and European engineering societies along standardization and public affairs lines.

Most SAE members know about the tremendous expansion that has taken place in European automotive production in the last five years. This expansion shows no signs of leveling off. Instead, every country appears to be further expanding its production facilities . . . and planning for more expansion in the near future.

Planned increases in European production facilities range up to 100% for some of the smaller, and some not-so-small, companies.

The American market has been becoming an ever bigger part of European exports — and most European companies are planning to increase their penetration of our American market. This is causing some concern among forward-looking management people in Europe. They fear the dangers that fluctuations in American demand present to their objective of growing-but-stable employment in European companies and countries.

The Europeans are much interested in the possible impact of our new compact cars on European car sales in United States. European opinions range from "No effect" to a belief that our compact cars might help the sale of foreign cars in United States. Others are definitely concerned about the inroads our compact cars may make. Executives of several smaller European companies commented: "The volume of sale of our cars is too small to be influenced by the sale of American cars."

European Common Market

The European Common Market and its prospects were a very popular subject of discussion. Our European friends are intensely interested in this commercial and political entity. The objectives of this European Common Market — which comprises Belgium, France, Germany, Holland, Italy, and Luxembourg — are:

- Closer commercial ties through lower internal tariffs;
- Integrated policies on transportation, agriculture, and social legislation;
- Eventual political hegemony.

A number of top European executives are very optimistic about the ECM's becoming a fully operational development within the next 10 years. The ECM is expected to lead, not only to elimination of trade barriers, but also

in Technology and in Industry

to promotion of much greater and freer exchange of technical and commercial information.

Some European builders recognize that they will lose their existing protected status in their countries. But, they indicate, they expect to be more than compensated by the much larger Common Market that will be open to them . . . and by the improved standard of living and purchasing power.

The automotive industry throughout Europe has been a major factor in its economic recovery. Wages in European automotive factories have increased appreciably in the last two years, with resultant improvement in individual purchasing power and standard of living. One very graphic proof of this is the smaller number of bicycles and scooters and the great increase in cars and parking lot areas in several European plants.

Although in some cases, it still takes two years in wages for an automobile factory employee to buy his company's product, current wage figures indicate that the gap between European and American earnings has been substantially reduced in some countries. It is also probable that labor shortages and other factors will cause pressure for further wage increases in several countries. In Germany, for example, three reasons for automation are given: (1) to reduce costs; (2) to improve uniformity and quality; (3) to release manpower for other jobs in the plant.

Some believe the European-American wage differential will gradually be eliminated because raising the standard of living and the real income of European workers is an absolute necessity.

Comparison of direct earnings between Europe and America, incidentally, can be quite misleading . . . not only because of differences in purchasing power, but because of indirect payments by companies of many social benefits. In one company, for example, the cost of life insurance, health coverage, vacation facilities and other social benefits is one-and-one-half times the direct average wage.

In some countries the size of a given plant is determined by the manpower in the area, rather than by a desire to decentralize operations. Because of tax or other considerations, some companies make as many of their components as possible.

European builders place great emphasis on vehicle quality, and take particular pride in their low warranty expense. The structural and component durability problems are somewhat more severe in overseas operations than in the United States, due to differences in overloading, road conditions and other factors.

European automotive technology continues to surprise me because of what is accomplished by so few people. Relatively small engineering departments and less production-per-model bring both a need and a freedom for much originality and creativity. Europe may not be using some materials (such as fuels and lubricants) to their greatest advantage. But other materials (such as light metals) are being employed on an increasingly broad basis. Quite a wide range of opinion exists in Europe, however, as to the attractiveness of light metals in components like cylinder blocks, due to differences in experimental and service experience and cost.

European builders are continuing to concentrate on volumetric efficiency in their passenger car engines . . . particularly at the higher engine speeds at which European engines run most of the time. European builders have not seen the need for the high compression ratios reached by cars in the United States.

Diesels, in Europe, are used almost universally in heavy-duty commercial vehicles — and in many light duty commercial vehicles, too. Extensive current experimental work is under way on increased specific output for diesels through supercharging.

Cylinder liners are much more popular for European than for American engines. The Europeans claim a very long life, which is said to be worth much more than the additional cost of the liners. They also say that the wet

AMONG the many engineers and executives who welcomed 1959 SAE President Leonard Raymond on his European tour last fall — and discussed technical and economic problems — were:

ENGLAND:
M. Ronayne, *chief engineer*, J. E. Bywater, *assistant chief engineer*, and L. Martland, *manager, Engineering Research Center, Birmingham, Ford (Dagenham)*; P. Copelin, *managing director*, Maurice Platt, *chief engineer and director*, C. A. Riddell, *director of manufacturing*, and G. C. Welby, *director of sales, Vauxhall (Luton)*; A. S. Dick, *president*, E. W. Tustin, *executive director*, H. Webster, *chief engineer*, and L. H. Dawtrey, *R & D, Standard Motors (Coventry)*; J. S. Clarke, *chief engineer*, and E. A. Watson, *consultant, Joseph Lucas, Ltd. (Birmingham)*; A. Fogg, *director, Motor Industry Research Association (MIRA), (Lindley)*; Alfred Towle, *managing director, Lubrizol International Laboratories (Hazelwood)*; L. H. Dawtrey, *chairman*, and R. Main, *secretary, Automobile Division*, and H. Desmond Carter, *president*, and Brian Robbins, *secretary, Institution of Mechanical Engineers;* C. M. Vignoles, *president*, and D. A. Hough, *secretary, Institute of Petroleum.*

FRANCE:
P. Dreyfus, *president*, F. Picard, *director of research*, and H. L. Brownback, *consultant, Renault (Paris, Billancourt, Flins)*; H. T. Pigozzi, *president*, G. Nonat, *production manager*, and L. Eberseercher, *assistant to president, Simca (Paris)*; J. P. Peugeot, *president*, M. Jordan, *general manager*, and Roland Peugeot, *assistant to president, Peugeot (Paris)*; R. Navarre, *president*, M. Buty, *chief engineer*, and R. Vishnievsky, *assistant director, Institut Francais du Petrole (Rueil-Malmaison)*; F. Picard, *president*, and R. Geffroy, *secretary general, Société des Ingénieurs de l'Automobile (SIA)*; L. Coatalen, J. H. Labourdette, *past presidents*, and P. Dumanois, *honorary president SIA.*

GERMANY:
F. Nallinger, *director and head of research and engineering*, Uhlenhaut, *chief development engineer, engines*, E. Stump, *chief development engineer, diesel engines*, and E. Kruppke, *head, fuels and lubricants, Daimler-Benz (Stuttgart)*; G. Winstrom, *works manager*, Zdunek, *general manager*, and H. Mertz, *research and engineering, Opel (Russelsheim)*; H. Nordhoff, *president*, and O. Hohne, *production manager, Volkswagen (Wolfsburg)*; Prof. P. Koessler, *chairman*, and Dr. Brenken, *secretary, Verein Deutscher Ingineure.*

HOLLAND:
W. van Doorne, *director*, and W. W. Seyffardt, *manager, DAF (Eindhoven)*. Prof. H. C. A. van Eldik Thieme, *Delft Technische Hogeschool (Delft)*; F. G. van Asperen, *chairman*, and M. J. van der Zivden, *secretary, Motor Technisch Colloquium;* W. W. E. von Hemert, *chairman*, and P. Dijksman, *secretary, Royal Institute of Engineers.*

ITALY:
G. Bono, *executive vice-president and general manager*, D. Giacosa, *director of engineering*, C. F. Bona, *manager of laboratories*, and E. Palamara, *director, lubricant activities, Fiat (Turin)*; Ing. Beccaria, *head of engineering*, and Ing. Filtri, *laboratory manager, O.M. (Brescia)*; A. Fessia, *general manager*, and Ing. Castiglione, *chief engineer, Lancia (Turin)*; Prof. A. Capetti, *president*, and M. Marchisio, *secretary, Associazione Technica del l'Automobile* (ATA).

SPAIN:
C. Boada Vilallonga, *general manager, Pegaso, Madrid;* W. P. Ricart, *director general (CETA)*; R. Calvo, *director general, Centro de Estudios Technicos de Automocion (INTA), (Madrid).*

SWEDEN:
S. Holm, *president*, C. Ljungstron, *chief engineer*, and R. Mellde, *chief engineer-research, SAAB (Trollhattan)*; T. Lidmalm, *vice-president and director*, and A. Larborn, *chief engineer, Volvo (Goteborg)*; F. Hedlund, *chief engineer, Scania-Vabis (Sodertalje)*; V. H. Sten, *chairman, Mechanical Branch*, E. Niveus, *secretary*, H. Bjorck, *vice-chairman, Fuels and Lubricants Committee*, and E. Bristedt, *chairman, Fuels and Lubricants Committee, Swedish Society of Engineers and Architects.*

Raymond in Europe

cylinder liner may not cost very much more than the integral block, because of excellent overall machineability of the engine.

The basic longing of European drivers for more power and speed isn't much different from that of American drivers, I would guess . . . except that the European desire is inhibited by the hard realities of the vehicle's original cost and the subsequent cost of fuel (largely taxes) required to run it.

Similarly, automatic transmissions would be just as nice to have in Europe as in United States. But their cost in Europe, in comparison to the overall cost of the vehicle, is very high. Also, the adverse effect of the automatic transmission on engine power and fuel requirement militates against its use in Europe.

Visiting plants and laboratories, I was much impressed with the ingenuity shown in developing special tests devices. I couldn't help sometimes recalling that "Boss" Kettering said at the dedication of General Motors great Technical Center: "It still takes people to make these elaborate, new facilities productive."

Apprentice schools are widely used in European factories. Many such schools take students at 14 or 15 years of age and put them for several years through an intensive curriculum, involving much practical training along mechanical and electrical lines. I was told that very few of these young men later seek employment outside the factory where they have completed their schooling.

European executives commented on several occasions about the secrecy which traditionally surrounds European technical and manufacturing operations, as compared to the relative openness characteristic of the United States. Many Europeans look to the European Common Market development to break down much of that tradition of secrecy.

Trying to convey a picture of basic American factors in this regard, I pointed out that European secrecy might give a particular manufacturer a bigger piece of a certain-sized pie at a given time. Freedom of interchange in America, however, aimed at producing a bigger pie, so that everybody could have a bigger piece.

Some steps toward better interchange of information is already taking place in Europe, however. Small groups of production men are being exchanged among several of the larger companies. As time goes on, we may expect greater freedom of publication of new technical information by European engineers.

The Society of Automotive Engineers is greatly respected in Europe, not only because it is by far the largest automotive engineering society in the world, but to an even greater extent because of its methods of operation and its accomplishments.

GERMANY — In Stuttgart, Raymond addressed the Verein Deutscher Ingenieure. . . . In Hamburg, he talked before a group of automotive and petroleum industry executives, some of whom came from considerable distances. Following the latter meeting, he chatted with H. H. Matthiessen, president, Mobil Oil A. G. (Germany) — on the left — and other guests.

HOLLAND — At lunch prior to addressing a combined meeting of Motor Technisch Colloquium and the Automobile Section of the Royal Institute of Engineers (Netherlands), Raymond sits between Chairman W. W. E. von Hemert of the Institute (left) and Chairman F. G. von Asperen of the MTC (right). The meeting was held at Hotel Smits, Vredenburg, Utrecht.

ENGLAND — In London, Raymond addressed meetings of both the Institute of Petroleum and the Automobile Division of the Institution of Mechanical Engineers. At the latter meeting his hosts were (left to right): L. H. Dawtrey, chairman of IME's Automobile Division; R. A. Wilson-Jones, past chairman of IME's Automobile Division, and H. Desmond Carter, president of the Institution of Mechanical Engineers.

ITALY — Raymond's talk in Italy to the Associazione Tecnica dell 'Automobile was delivered in the famous Leonardo da Vinci National Museum of Science and Technology. Seated beside him on the dais (left to right) are Renault's Fernand Picard, who is president of the French SIA; Professor A. Capetti, president of ATA; A. Firpo, Italian Ministry of Transportation; and G. Alfieri, chairman of ATA's Milan Section. . . . The interview with Raymond in the Museum's patio was later broadcast on an Italian television network. ATA conferred an honorary membership on Raymond during his visit.

SWEDEN — Scandanavian Airlines System carried Raymond from Stockholm to London, following his talk before the Swedish Society of Engineers and Architects. Front page stories in Stockholm's leading newspapers reported the Raymond visit and his address. The meeting started at 5 p.m., adjourned for dinner, and reassembled at 8 p.m. for nearly 2 hours of discussion. Raymond was awarded by the SSEA a bronze medallion bearing the Society's crest.

SPAIN — W. P. Ricart, past president of FISITA, was host to Raymond in Spain where some 50 guests talked with Raymond and he with them of automotive affairs in general. Ricart is director general of Centro de Estudios Technicos de Automocion.

FRANCE — Raymond's talk to a joint meeting of Société des Ingénieurs de l'Automobile (SIA) and the Fédération Internationale des Sociétés d'Ingénieurs des Techniques de l'Automobile (FISITA) was translated simultaneously into French as he delivered it. The SAE President's largest audience listened to this talk in the UNESCO Building in Paris. SIA conferred an honorary membership on Raymond, following his presentation. At the dinner following the address, P. Dumanois, Ingénieur General de l'Air (France) sat at Raymond's right; at his left was SIA President Fernand Picard.

A report from the COUNCIL

"A summary report of the actions of the Board of Directors shall be published in the next following issue of the official publication of the Society." . . . from C 6 of the SAE Constitution.

At the Jan. 15, 1960 meeting of the SAE Council, actions were taken as follows:

APPROVED

CONSTITUTION COMMITTEE report on SAE initials and emblem. **(Summary 1)**

PUBLICATION COMMITTEE report and recommendations. **(Summary 2)**

A response to **FISITA** suggestions for cooperative activities. **(Summary 3)**

SECRETARIAL MEMBERSHIPS to be exchanged on new basis. **(Summary 4)**

MEMBERSHIP GRADING COMMITTEE procedures and guideposts. **(Summary 5)**

Election to **SAE MEMBERSHIP** for 101 applicants. **(Summary 5)**

President Raymond's encouragement of continued efforts to improve **QUALITY OF TECHNICAL PAPERS. (Summary 5)**

TECHNICAL BOARD reports issued during 1959. **(Summary 5)**

REJECTED

26 applications for **MEMBERSHIP. (Summary 5)**

Recommendations of SAE member **H. H. WAKELAND** concerning constitutionality of a technical paper. **(Summary 6)**

TABLED

Proposal to increase the price of **SAE TRANSACTIONS. (Summary 7)**

DISCUSSED

Proposal to **INCREASE DUES. (Summary 8)**

(Summary 1)

Constitution Committee Report

The Constitution Committee was authorized to develop proposed amendments to the Constitution and By-Laws to:

1. Designate the initials "SAE" as the official abbreviation of the Society's name.
2. Formally specify the nature of the SAE emblem as to design, shape, and color.

Both the SAE emblem and the initials are also to be copyrighted. These actions stemmed from recommendations made by Vice-President Walker Gilmer.

(Summary 2)

Publication Committee Report

Four Publication Committee items were approved:

1. A statement of Publication Objectives, expressing the Publication Committee's "philosophy" was approved. It reads in part:

"The Publication Committee operation must publish and distribute high-quality technical material, that is of such a nature that it is of lasting value, in a manner that will assure its preservation — and in a form of high character. . . . It must also provide for rapid dissemination of current technical material in sufficient detail to inform its readers of the scope of the work, and direction as to where more complete information can be obtained."

2. Approved also were procedures, proposed by the Committee, to enable it "to work toward its 'Guidepost' directive of having Publications self-supporting."
3. SAE Journal was authorized to increase its advertising rates on Jan. 1, 1961.
4. SAE Handbook was authorized to increase its advertising rates, effective with the 1961 SAE Handbook.

(Summary 3)

FISITA Proposals

Growing out of his contacts in Europe, President Raymond received a proposal for formal cooperative ties between SAE and FISITA (Fédération Internationale des Sociétés d'Ingénieurs des Techniques de l'Automobile). FISITA is a federation of European automotive engineering societies.

The FISITA proposal consisted of these four points:

1. Close collaboration in the development of technical standards.
2. Better information interchange between SAE and the FISITA member societies on the respective meetings of each society.
3. Assistance in arranging introductions to plants and laboratories. SAE would extend this courtesy to FISITA members traveling in this country and SAE members would receive similar courtesies in Europe.
4. Alliance of SAE with FISITA to create a strong international body to speak for automotive engineers on a worldwide basis on matters of standards and recommended practices in dealing with government bodies.

In acting on the proposals, Council agreed that:

1. SAE continue at present with its informal relationships with FISITA.
2. SAE look to a growing understanding between both groups, with anticipations that circumstances in the future will be more conducive to more formal arrangements.
3. President Raymond be authorized to discuss with the Automobile Manufacturers Association the matter of international standards in the automotive field raised by FISITA officials.

(Summary 4)

Exchange Secretarial Membership

From now on, top staff officers of other engineering societies will be selected and qualified for Member grade by the SAE Board of Directors, without being subjected to the normal

Membership Grading Committee procedures.

The new method of processing these exchange memberships — suggested by the Membership Grading Committee — will be carried out under paragraph C 19 of the Constitution, which authorizes the Board of Directors to elect to Member grade "persons who by reason of distinguished service or noteworthy accomplishment would, in the discretion of the Board of Directors, appear to be desirable additions to this grade."

SAE has been exchanging secretarial memberships with selected societies for 23 years. The societies with which such an exchange exists are:

- American Society of Mechanical Engineers
- Institute of the Aeronautical Sciences
- Institution of Automotive and Aeronautical Engineers (Australia)
- Institution of Mechanical Engineers (England)
- Société des Ingénieurs de l'Automobile (France)

The Board of Directors agreed on the feasibility of a similar secretarial membership exchange with additional societies.

(Summary 5)

Other Council Approvals

Acting on Council's instructions, President Raymond will write to all Activity Committees to thank them for their productive efforts to improve the quality of SAE technical papers and to urge them to continue and expand their work in this direction.

Newly revised procedures and guideposts for the Membership Grading Committee bring these yardsticks for reviewing membership applications in line with the recently amended SAE Constitution and By-Laws.

Council acted favorably on 101 applications for membership, and also denied membership to 26 applicants.

Reports issued by the Technical Board in 1959 received formal Council approval.

(Summary 6)

Question Raised by H. H. Wakeland

Several months ago H. H. Wakeland, an SAE member, wrote to the members of Council regarding a paper, SP-165, "The Safety the Motorist Gets." This paper was presented at the 1959 SAE Summer Meeting and was coauthored by sixteen men.

Mr. Wakeland's main contention was that in his estimation, the technical content of the paper was such as to render the entire paper unconstitutional. He, therefore, proposed that the paper be expunged from the Society's records. He also proposed that the paper be withdrawn from Congressional records, since the paper had been submitted to a Congressional Committee as an example of the Society's function in serving as a medium of technical information exchange.

The Council unanimously agreed that the paper in question did not violate the Constitution. Therefore, it could not accept Mr. Wakeland's recommendations. In his letter advising Mr. Wakeland of Council's decision, President Raymond said:

"It would appear that perhaps there may have been departures from best practice in connection with the paper in question. We sincerely appreciate your calling them to our attention and we intend to see to it that they are not repeated in the future.

"However, after due deliberation and discussion of your presentation and recommended Council action, the members of the Council unanimously agreed that the paper in question is not incompatible with the SAE Constitution. Since the Council's interpretation of the Constitution is not in agreement with yours, the Council could not accept your recommendations."

(Summary 7)

Price of Transactions

For the time being the price of SAE Transactions will be maintained at the current $3.00 level.

The recommendation to increase the Transactions price to $6.00, temporarily tabled by the Council, grew out of an analysis showing that this publication service is operating at a substantial loss. Reasons for holding the price increase proposal in abeyance are:

1. The Publication Committee, with the help of the Publication Advisory Committee of the Engineering Activity Board, is working out a new conception for publishing SAE technical information. The Transactions may very likely be radically affected.

2. With a dues increase being proposed to Council and a study of SAE finances currently under way, consideration of a Transactions price boost would be ill-advised until other aspects of the SAE financial picture are clarified.

(Summary 8)

Proposal to Increase Dues

Council devoted considerable time to further exploration of the Finance Committee's proposal of last September to increase dues. The discussion focussed on two aspects of the problem:

1. Is there another way of producing the needed additional income, or reducing expenses?

2. How should the dues schedule be modified if a dues increase is to be instituted?

Additional information from the Finance Committee revealed that every other means of producing additional income had been carefully explored. None can yield the additional monies required. Expense curtailment is not the answer either. Efforts have been made to cut expenses and increase efficiency for a number of years, with salutary results. However, the end of the line has just about been reached via this route. Further expense cutbacks would bring a curtailment of member services, just at a time when the demand for member services is mushrooming.

Finance Committee analyses show that member service operations have been operating in the red for the past two years, with a budgeted deficit in member services this current year. The Finance Committee points out that since the financial weakness lies in the area of dues-supported services, the only sound avenue to financial stability is a dues increase.

A plan for modifying the dues schedule was proposed in a report prepared jointly by the Membership Committee Executive Committee and the Sections Committee Executive Committee. Still another revision of the dues schedule was suggested by Vice-President W. C. Heath.

President Raymond advised that action on the proposed dues increase would not be taken until the entire membership had an opportunity to understand the Society's current financial problem. A copy of his talk on this subject at the Annual Business Meeting was printed in the February issue of the Journal, p. 81. Similar discussions were held with key member groups during Annual Meeting.

The Board of Directors will consider the dues increase proposal at its April meeting, advised 1960 SAE President Chesebrough.

A report from the BOARD OF DIRECTORS

At the Jan. 15, 1960 meeting of the SAE Board of Directors, actions were taken as follows:

APPROVED

Selection of **E. N. COLE** to fill vacancy on 1960 Board of Directors. **(Summary A)**

ENGINEERING ACTIVITY BOARD report and recommendations. **(Summary B)**

Establishment of new **STUDENT BRANCH** at San Jose State College. **(Summary C)**

Further study on proposal to ease **FINANCIAL PROBLEMS** of Sections. **(Summary D)**

Rules and Regulations for **SECTIONS BOARD.** **(Summary E)**

SAE participation in **1960 NATIONAL AUTOMOBILE SHOW.** **(Summary F)**

SECURITY CLEARANCE for staff members requiring access to classified government material. **(Summary G)**

(Summary A)

E. N. Cole Selected to Fill Vacancy in 1960 Board of Directors

Because of the election of Harry E. Chesebrough to the Presidency, there was a vacancy on the Board of Directors for 1960. Mr. Chesebrough had originally been elected as a Councilor for 1959–1960. Under the newly amended Constitution, men who had been elected as Councilors are to serve as Directors on the 1960 Board of Directors.

In accordance with the provisions of C 7 of the Constitution, the Board of Directors selected E. N. Cole, General Manager, Chevrolet Motor Division, General Motors Corporation, to fill this vacancy. Mr. Cole's acceptance has been received.

(Summary B)

Engineering Activity Board Report

The Engineering Activity Board submitted to the Board of Directors a set of rules and regulations governing its own operations and those of committees reporting to EAB. This document was approved as submitted. (Copies of the Engineering Activity Board's Rules and Regulations have been sent to each member of the fifteen Activity Committees.)

The Directors also approved the schedule of SAE National Meetings for 1961 and 1962 as proposed by the Engineering Activity Board. Among the items noted in the schedule was the location of the 1961 Summer Meeting at St. Louis, Missouri, using the facilities of the Chase-Park Plaza Hotel.

The Directors also approved a plan for the 1961 Annual Meeting to bring foreign participation into the technical program and into other phases of the Meeting.

(Summary C)

New Student Branch

A Student Branch Charter was granted to the SAE student organization at San Jose State College. Appropriate supporting letters for this move had been received from Officers and members of the Northern California Section who had been in close contact with the SAE Student activity at the College. The move had the endorsement of the Sections Board and its Student Committee.

(Summary D)

Section Finances

The Sections Board reported that its committee on Section finances found a growing need for financial relief, particularly among the Society's smaller Sections. The pinch of inflation is making it increasingly more difficult to operate on a break-even basis.

The Sections Board recommended that up to $150 be made available to each Section and Group upon request by their respective Governing Boards. This amount is to supplement the $4.00 for each member within its territory which each Section and Group receives from the Society.

The Directors accepted this report in principle, but postponed action on it. The Sections Board was requested to study further a means of administering these proposed supplemental monies to be given to Sections and Groups to assure equitable distribution of these funds.

(Summary E)

Sections Board Rules and Regulations

Directors approval of a set of rules and regulations gives the Sections Board a document for governing its operations and those of its committees.

(Summary F)

Participation in the 1960 National Automobile Show

SAE accepted an invitation from the Automobile Manufacturers Association to participate in the National Automobile Show to be held at Cobo Hall, Detroit, in October 1960. The Society was asked to participate in the institutional and educational supplement of the Automobile Show. The Directors voted to accept the invitation with the following provisions:

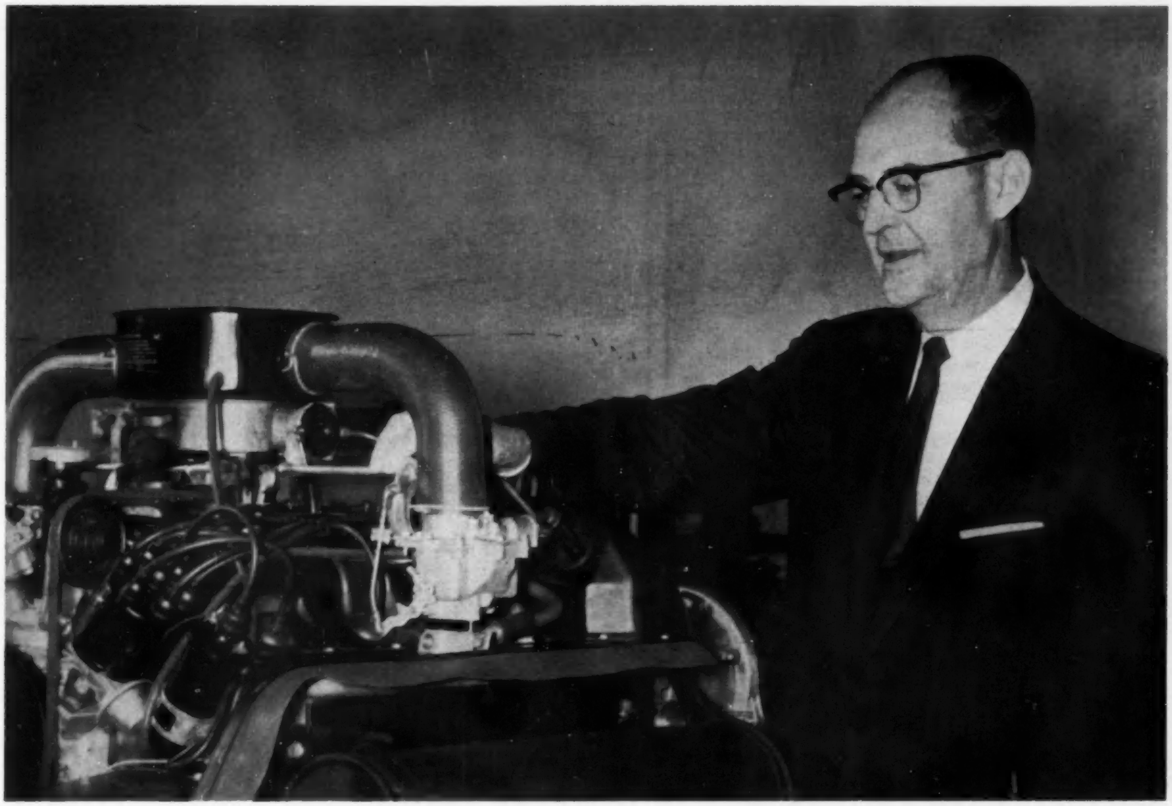
1. Such participation will involve no out-of-pocket expenditure by SAE.
2. The Detroit Section will cooperate in developing and executing a program of SAE participation. (Detroit Section Officers had previously indicated informally their willingness to do so.)

(Summary G)

Security Clearance

As required by the Eastern Industrial Security Regional Office of the Air Research and Development Command, the Directors approved the resolution with regard to handling of classified material at SAE Headquarters. This resolution, which is handled as a routine matter each year, specifies that the members of the SAE Board of Directors have no need to have access to classified military material in possession of security-cleared SAE staff personnel. The resolution further specifies the staff members who have authority for processing and handling classified information.

"A summary report of the actions of the Board of Directors shall be published in the next following issue of the official publication of the Society." . . . from C 6 of the SAE Constitution.



H. F. Barr

1960 chairman SAE Engineering Activity Board

BEING the chief engineer of a company that designed and developed over 200 models of passenger cars and trucks for 1960 is a demanding job. It calls for a delicate mixture of talents — engineering ingenuity, administrative skill, and great self-composure under pressure. The chief executive of the Chevrolet Engineering Department, H. F. Barr, has all these necessary attributes.

Harry Barr is a personable man of medium height and build and his friendly warmth acquits him well, both in meeting the public and in his working relationship with the 3000 people that make up Chevrolet Engineering.

He was born 54 years ago in Enid, Okla. As a youth on a farm in Missouri he demonstrated an insatiable interest in his uncle's Model T Fords. This early attraction to cars grew to be an unwavering determination to become an automotive engineer. He studied mechanical engineering at the University of Detroit, from where he was graduated in 1929.

After graduation, he promptly got a job at Cadillac.

In succeeding years, he advanced through positions of increasing responsibility — with the assignment emphasis being on engine design and development. When Cadillac began building tanks for the armed forces in World War II, he became engaged in this activity. As staff engineer after the war he was responsible for the design and development of the first modern short stroke overhead valve V-8 engine introduced by Cadillac in 1948. In 1950 Harry Barr was assigned to the Cadillac Tank Plant in Cleveland as chief engineer.

The following year he returned to Detroit as an assistant chief engineer of Cadillac.

Barr came to Chevrolet in 1952 as an assistant chief engineer in charge of engine and passenger car chassis as part of a dynamic new engineering team headed by E. N. Cole. In his new capacity, he was responsible for much of Chevrolet's success in short stroke, V-8 engine development.

Under Barr's leadership as chief engineer since 1956, Chevrolet engineers have designed and developed the all-new 1958

This is the second of three profiles covering the chairmen of the three SAE Boards under whose leadership much of the Society's work is now proceeding.

In the February issue of SAE Journal, a profile of Dr. Andrew A. Kucher, chairman of the SAE Technical Board, appeared.

In the April issue, a profile of William F. Ford, chairman of the SAE Sections Board, will appear.

H. F. Barr

. . . continued

passenger car line and introduced the new Impala models; and for the 1960 model year, the new Corvair and 185 truck models of completely new design.

The focal point of Harry Barr's operations is Chevrolet's vast Engineering Center, located adjacent to General Motors' Technical Center. If he can't be found in his office, he is apt to be in one of several places in the Center: viewing a new design concept in the research and development area; checking the progress of an experimental vehicle program; reviewing special test data in the laboratory; or discussing policy or a knotty mechanical problem in the office of one of his assistant chiefs.

It takes a good man to thrive under the pressures of the "annual model change" milieu of American automotive engineering, and Harry Barr is

1960 SAE Engineering Activity

Term expiring at the end of the 1960


D. M. Adams


O. A. Brouer


F. W. Fink


W. W. Henning


C. F. Nixon


Karl Pfeiffer

Term expiring at the end of the 1961


R. E. Cross


J. T. Dyment


W. Paul Eddy


P. S. Myers


F. A. Robbins

Term expiring at the end of the 1962


R. H. Isbrandt


A. L. Klein


C. R. Lewis


E. J. Manganiello


V. G. Raviolo


K. W. Stalker

such a man. Yet in spite of his schedule, he has found time to devote to SAE, which he joined in 1941. More recently he was assistant vice-chairman of the passenger car activity in the Detroit Section. Barr brings invaluable automotive engineering experience to his position as the first chairman of the new SAE Engineering Activity Board.

Board

administrative year

Randall Roman

A. O. Willey

administrative year

S. J. Tompkins

W. W. Withee

administrative year

J. E. Taylor

T. L. Swansen

1960 SAE Engineering Activity Board

H. F. Barr, Chairman
Chief Engineer
Chevrolet Motor Division, General Motors Corp.

Term expiring at the end of the 1960 administrative year

D. M. Adams
Staff Engineer, Cadillac Motor Car Division
General Motors Corp.

C. F. Nixon
Head, Electrochemistry and Polymers Dept.
Research Laboratories, General Motors Corp.

O. A. Brouer
Head, General Automotive Division
Swift & Co.

Karl Pfeiffer
Executive Engineer
Engineering Division, Chrysler Corp.

F. W. Fink
Vice President — Engineering
Ryan Aeronautical Co.

Randall Roman
Chief Engineer
Peoria Plant, Caterpillar Tractor Co.

W. W. Henning
Manager, Engineering Farm Equipment Group
International Harvester Co.

A. O. Willey
Executive Vice-President — Engineering
Lubrizol Corp.

Term expiring at the end of the 1961 administrative year

R. E. Cross
Executive Vice-President
The Cross Co.

P. S. Myers
Professor of Mechanical Engineering
The University of Wisconsin

J. T. Dyment
Chief Engineer
Trans-Canada Air Lines

F. A. Robbins
Chief Engineer
Metal Products Division, Koppers Co., Inc.

W. Paul Eddy
Chief, Engineering Operations
Pratt & Whitney Aircraft Division
United Aircraft Corp.

S. J. Tompkins
Chief Engineer & Director, Truck Product
Dodge Car & Truck Division, Chrysler Corp.

W. W. Withee
Assistant Chief Engineer — Testing
Convair-Astronautics Division, General Dynamics Corp.

Term expiring at the end of the 1962 administrative year

R. H. Isbrandt
Director, Automotive Engineering & Research
American Motors Corp.

V. G. Raviolo
Executive Director, Engineering
Ford Motor Co.

A. L. Klein
Consultant
Douglas Aircraft Co., Inc.

K. W. Stalker
Manager, Engineering
Goodman Mfg. Co.

C. R. Lewis
Chief Engineer, Basic Sciences Laboratories
Engineering Division, Chrysler Corp.

T. L. Swansen
Vice-President
Ladish Co.

E. J. Manganiello
Associate Director, Lewis Research Center
National Aeronautics and Space Administration

J. E. Taylor
Director, Automotive Research
Gulf Research & Development Co.

SAE's CEP News

Cooperative Engineering Program

Hammond Joins SAE Technical Board

Hammond

DEAN B. HAMMOND, Willys Motors' vice president of engineering, has been appointed a member of the SAE Technical Board. He fills the vacancy created by George W. Mork who, due to business commitments, resigned after having served a third of his three-year term.

Hammond brings a unique combination of aircraft and passenger car experience to the Board. After receiving a B.S. degree in aeronautical engineering from the University of Michigan, he became president of the Hammond Aircraft Corp. Twelve years later, he went to the Henry J. Kaiser Co. as manager of the Experimental Division. He subsequently became chief engineeer and vice president of automotive engineering for the Kaiser Frazer Corp.

In 1953, Hammond joined Willys where he is currently responsible for all product engineering and research activity.

16 Strengthen SAE Link With Outside Technical Groups

AT THE BEHEST of the 1960 SAE Technical Board, 16 men will join the existing network of over 100 who serve as offical SAE representatives in approximately 32 outside technical groups. Each qualifies for his assignment on the basis of engineering ability and experience in a specialized area.

Appointments made at the January 14 Technical Board meeting in Detroit run as follows:

O. I. Rugg, divisional glass technologist, Ford Motor Co., **H. C. Mead**, director of reliability, GMC's Guide Lamp Division, and **C. W. Jackman**, assistant staff engineer, trucks, Chevrolet Motor Division, will participate at meetings of the National Conference of School Transportation.

J. A. Kabrud, design procedures unit chief, Aero-Space Division, Boeing Airplane Co., will represent SAE on ASA Sectional Committee Y1, Abbreviations.

Ralph Clark, manager of foundry service, Union Carbide Metals Co., will represent SAE on ASTM Committee A-3, Cast Iron.

E. J. Stockum, vice president, research and development, Dayton Malleable Iron Co., will represent SAE on ASTM Committee A-7, Malleable Iron Castings, and ASTM Committee A-7's Subcommittee IV, Pealitic and Alloy Malleable Iron.

H. K. Gandelot, engineer in charge of GMC's Vehicle Safety Section, **L. H. Nagler**, staff engineer, safety, Office of Director of Engineering, American Motors Corp., and **Ormund L. Rugg**, divisional glass technologist, Ford Motor Co., will represent SAE on ASA Sectional Committee Z26, Safety Glazing Materials. (**Richard Cook**, International Harvester Co., and **W. C. Lang**, Chrysler Corp., will serve as alternate representatives.)

J. A. Gavin, plant engineer, Trenton Plant of GMC's Ternstedt Division, will represent SAE on ASA Sectional Committee B55, Standardization of V-Belts and V-Belt Drives.

H. K. Gandelot, engineer in charge of GMC's Vehicle Safety Section, and **Kenneth A. Stonex**, assistant director, GMC Proving Ground, have been reappointed as SAE representative and alternate respectively on the ASA Highway Traffic Standards Board, for a term of two calendar years.

F. A. Kocian, chief engineer, International Harvester's Farm Equipment Division, will be the SAE representative on ASA Sectional Committee B18, Standardization of Bolts, Nuts, Rivets, Screws and Similar Fastners.

Dr. Lloyd Withrow, head of the Fuels and Lubricants Department, GMC's Research Labs., will be the SAE representative on ASTM Committee Z11, Petroleum Products and Lubricants.

SAE Ground Vehicle Reports to be Numbered

IMPLEMENTATION of a numbering system to identify all SAE ground vehicle reports was endorsed by the Technical Board at its January 14 meeting in Detroit. This action results from Publication Policy Committee efforts to facilitate industry referencing techniques and promote the use of SAE Standards.

As directed by the Technical Board, the SAE staff is investigating feasible numbering systems. This study will form the basis of suggestions to be made to the PPC which, in turn, will coordinate technical committee reaction and develop recommendations for Technical Board approval.

ISTC Panels Get New Chairmen

Husemann

Runkle

ZurBurg

Spencer

HEADING the Iron and Steel Technical Committee's four top advisory groups during the ISTC Golden Anniversary Year are E. W. Husemann, D. F. Rundle, H. H. ZurBurg, and T. H. Spencer. As 1960 Panel chairmen, they will lead a combined force of 182 metallurgists who help the ISTC Executive Committee key the activities of some 30 working divisions to user-producer needs.

Since the first of the year, ISTC Panels have set in motion projects on decarburization limits, casting design information, fatigue, and hardenability bands for carbon steel similar to those established for alloy steels. They will continue to advise the Executive Committee under the leadership of the following.

E. W. Husemann, incoming chairman of Panel A — Steel Producers, is chief metallurgist at the Copperweld Steel Co. where he is responsible for quality control plus research and development at Copperweld's Steel Division. During his 35-year metallurgical career, he has been instrumental in refining processes and in improving melting procedures. Prior to joining Copperweld in 1942, Husemann headed the Coding and Specification Department and was western manager of claims at Republic Steel's South Chicago Plant.

D. F. Runkle, incoming chairman of Panel B — Castings, is managing engineer of Chrysler's Metallurgical Research Department. His Chrysler affiliation began in 1951 when he worked under Walter Jominy and conducted cast metals research. Before that, he was assistant plant manager of the Campbell Wyant and Cannon Foundry Co.

H. H. ZurBurg, incoming chairman of Panel C — Automotive, is assistant chief engineer, metallurgical development, Chrysler Corp. A graduate of the Chrysler Institute of Engineeering, he began at Chrysler as a project engineer working on rear axle gears. He subsequently did metallurgical and contact work at the Dodge Main Plant. Later, he became a laboratory supervisor, head of the Metallurgical Department, and, in 1956, assistant chief engineer for metallurgical development.

T. H. Spencer, incoming chairman of Panel D — Tractor and Earthmoving, is quality control manager at Caterpillar's Peoria Plant. The originator of several patents in the heat treat and metallurgical fields, he was plant metallurgist in the Metallurgical Division and manager of the Heat Treat Division prior to assuming his present post.

Technishorts . . .

TRACTOR MOUNTED SIDE BOOMS — The CIMTC's reactivated Subcommittee XI is expanding the scope of the SAE Recommended Practice, Crawler Tractor Side Mounted Pipe Booms, to include *wheel-type* side booms as well as crawler types. As a result, the report's name has been changed to Tractor Mounted Side Booms . . . and specifications, test procedures, and definitions are being up-dated.

AIR SPRING TERMINOLOGY — Demands for a uniform nomenclature for this type of motor vehicle suspension system led to the development of the new SAE Information Report, Air Spring Terminology, which was recently approved by the General Standards Council. The document was prepared by vehicle suspension experts and rubber products engineers who serve as members of the Air Spring Subcommittee of SAE's Spring Committee. It is scheduled to appear in the 1961 SAE Handbook.

NON-THREADED FASTENERS — Mechanical and Chemical Requirements for Non-Threaded Fasteners, a new SAE Recommended Practice, has been approved by the Technical Board's General Materials Council. It contains specifications for mechanical and chemical requirements for carbon steel solid rivets and is scheduled to appear in the 1961 SAE Handbook.

The report is the work of ISTC Division 29, Physical Requirements for Threaded Fasteners, which hopes to expand the report to include other fasteners in the future.

IMPROVED CONTRAST IN WARNING LIGHTS — The SAE Lighting Committee demonstrated improved contrast for warning lights to the 1959 National Conference on School Transportation. As a result, the school bus code sponsored by this group will call for a black border circling flashing red signal lights. A similar recommendation is already contained in the SAE Standard, Warning Signal Lamps for School Buses and Emergency Vehicles.

SAE's CEP News

COOPERATIVE ENGINEERING PROGRAM

SAE Technical Board Council Sponsors for 1960

LAST year's Technical Board reorganization gave rise to a new breed of men who serve SAE as *Council sponsors*. These men are agents and members of the Technical Board as well as members of a Council of the Board. Each serves on a Council which lies in an area of special interest to him and is chiefly responsible for:

- Keeping Board members abreast of Council actions in addition to those of technical committees reporting to that Council.
- Representing a Council in the event of a conflict between two Councils.
- Seeking Board advice on problems arising within a Council or committee of that Council.
- Seeing that a Council's committees are fulfilling *real* industry needs. This might require the instigation of new groups or the disbanding of those which have achieved their goal.

Sponsors share equally in these responsibilities and are appointed for one-year terms by the Board chairman. They may be reappointed as long as they serve on the Technical Board.

Aero-Space Council	Automotive Council	General Materials Council	General Standards Council
*C. L. Sadler, Chairman	G. J. Huebner, Jr., Chairman	M. L. Frey, Chairman	E. C. Brown, Chairman
M. G. Beard	R. R. Burkhalter	F. L. LaQue	G. E. Burks
M. C. Hemsworth	Oliver K. Kelley	J. G. Moxey, Jr.	W. F. Burrows
Arthur Nutt	D. B. Hammond		K. W. Tantlinger
W. A. Pulver	Merlin Hansen		
R. W. Young	E. J. Hardig		

* Although Sadler is not a Technical Board member, his continuance as chairman of this Council has been approved by the Board's Executive Committee.

ISTC Ventures Into New Area

Chapman

FORMATION of the Iron and Steel Technical Committee's new Division 35 on Elevated Temperature Properties of Ferrous Materials marks the first ISTC venture into an area hitherto considered the domain of aircraft.

The Committee's decision to move into this area stems from several facts:

(1) Certain construction materials used in existing ground vehicle reciprocating engines encounter elevated temperature conditions which affected their normal properties.

(2) Very little information on these effects and their significance is currently available in the SAE Handbook.

Richard D. Chapman, assistant chief engineer of metallurgical research at Chrysler, will head the new group. In making the appointment, 1959 ISTC Chairman E. S. Rowland stated that Division 35 would confine its development of technical information to ground vehicle applications.

Course Charted by . . .

New Aero-Space Training Device Committee

AN information development program related to . . .

- The degree of simulation required to validate military *and* civil aircraft components, systems, and equipment for the purpose of training groups or individuals to use and maintain the real thing, plus
- Special skills (such as language, special programming, and survival procedures) not involving the operation or maintenance of hareware

. . . has been devised by SAE's new Aero-Space Committee GSE-3, Training Devices. At a kick-off meeting called by Chairman J. N. Pecoraro, U. S. Naval Training Device Center, twenty-five engineers from twenty-two user-producer organizations were on hand to spell out the above as well as to create five working subcommittees.

Classroom Trainers

Concurrent with the main meeting, two of the subcommittees met for the first time. Led by P. H. Selby, Convair, the Classroom Trainers Subcommittee began a classification of training devices in an effort to establish a spring board for future GSE-3 activity. The premise of the classifications is that trainers are designed to do three things:

- Train people to operate equipment.
- Train people to maintain equipment.
- Teach individuals special skills as defined above.

Thus, the following evolved:

Basic Trainers — meant to develop knowledge and skill by using open and closed loop training techniques.

Maintenance Trainers — applicable to components, systems, and checkout.

Operational Trainers — involving:

- Procedure trainers
- Animated system trainers.
- Simulators for navigation, environment, flight, and tactics.

Research and Development Designs — including man-machine systems, human behavior, and special training techniques.

Land Mass Simulation

Two techniques used to simulate land mass were defined by the Land Mass Simulation Subcommittee which also met during the GSE-3 meeting. They include:

Closed Loop Techniques . . . where the trainee is an active participant and feeds information into the system and effects what he sees.

Open Loop Techniques . . where the trainee is passive and merely an observer.

The closed loop technique presupposes the use of radar, ultrasonis, transparency, opaque models, projection using optics, infra-red, television, and direct optics.

In addition to the Land Mass Simulation Subcommittee, which is headed by Mitchell Aron, U. S. Naval Training Device Center, the following groups were formed.

Research Subcommittee . . Dr. A. F. Smode, Dunlap and Associates, Inc., will serve as chairman .

Environment Simulation Subcommittee . . S. J. Miller, International Radiant Corp., chairman.

Computer Components Subcommittee . . W. G. Heffron, Melpar, Inc., chairman.

GSE-3 Chairman Pecoraro plans to call the next full committee meeting in the early Spring. GSE-3's third meeting will be held on the West Coast next fall.

THE KICKOFF MEETING of SAE's new Aero-Space Committee GSE-3, Training Devices, was held January 25 in New York . . . where work began on a land mass representation project. Seated from left: P. H. Selby, Convair; M. D. Bennett, Reflectone Corp.; Mitchell Aron, Curtiss Wright Corp.; H. N. Bowes, General Dynamics's Electric Boat Co.; Chairman J. N. Pecoraro, U. S. Naval Training Device Center; R. A. Collins, Capital Airlines; Dr. A. F. Smode, Dunlap and Associates, Inc.; W. O. Packer, ERCO-ACF Industries; and Col. H. C. Davall, Federal Aviation Agency's Training Division.

Standing from left: L. D. Duerst, Boeing Airline Co.; J. R. Pears, North American Aviation; L. V. Foster, Bausch and Lomb Optical Co.; G. M. Young, Douglas Aircraft Corp.; H. P. Douglas, Lockheed's Stavid Division; W. C. Carr, North American Aviation; B. C. Jorgenson, Western Airlines; S. J. Miller, International Radiant Corp.; Paul Rudoff, McDonnell Aircraft Corp.; W. B. Brown, United Airlines; C. O. Miller, Chance Vought Aircraft; and J. D. Wilfley, Link Aviation, Inc.

Also present: R. D. Kelly, United Airlines; L. J. Gale; Burton-Rodgers, Inc.; W. G. Matheny, Bell Helicopter Corp.; and P. E. Young, Federal Aviation Agency.

Chairman Pecoraro

SAE MEMBERS

LLOYD A. CUMMINGS has retired as vice-president of manufacturing after 38 years with Marlin-Rockwell Corp. He was chief engineer for the company until 1947 when he was named vice-president and appointed a member of the board of directors, a post he will continue to hold. He will also continue to serve the company as a special consultant.

Cummings has been a member of SAE since 1915. He is currently chairman of SAE Ball and Roller Bearing Technical Committee and has been a member of the Iron and Steel Technical Committee.

JOHN E. LEE, who is director of research, United Aircraft Corp., has been chairman of the Board of Regents of the University of Hartford, since its founding in 1957, when three 75-year-old colleges were joined together: Hartford Art School, The Julius Hartt Musical Foundation, and Hillyer College. Present enrollment is slightly over 1000 full-time students; slightly over 10,000 part-time.

Commenting on this avocational interest, Lee reports: "The institution is a community college, coeducational, non-sectarian, and non-profit. It gives courses in fine arts and music (both at the professional level), business administration, engineering, liberal arts and education."

JAMES M. CRAWFORD, president of the La Jolla (Calif.) Art Center, gave a brief welcoming address at the dedication of the Center's new $700,000 wing on Jan. 10. Crawford, who was president of SAE in 1945, has headed the Center for several years and has played an important part in development and financing which led to the new wing. A new auditorium has a stage 46 ft wide and 31 ft deep, while five new studios will provide needed classroom space for the Center's School of Arts and Crafts. The wing also includes an additional picture gallery, a sunken sculpture garden, and administrative offices.

SAE DIRECTOR HAROLD HOEKSTRA, chief project officer of transports, Bureau of Flight Standards, Federal Aviation Agency, was a member of a panel on "Air Crashes and Air Safety" at the recent annual convention of the International Academy of Trial Lawyers at Jamacia, British West Indies.

W. P. MICHELL has been given a special assignment as consultant to **E. M. Douglas**, vice-president for engineering at Dana Corp.

Michell joined Dana in 1946 as engineering assistant to the vice-president and subsequently he became chief development engineer.

ELMER A SPERRY, JR., vice-president of Sperry Products, Inc., has been named an honorary fellow of the Institute of Aeronautical Sciences.

E. J. MANGANIELLO, associate director, National Aeronautics & Space Administration, Lewis Research Center, and **LYSLE A. WOOD**, vice-president of Boeing Airplane Co. and general manager of Boeing's Aero-Space Division, have been named fellows of the Institute of Aeronautical Sciences. Manganiello is a member of the 1960 SAE Engineering Activity Board.

DR. AUGUSTUS B. KINZEL, vice-president in charge of research at Union Carbide Corp., has been elected 1960 president of Engineers Joint Council.

DR. W. WAI CHAO has been appointed Chief of Research at Vickers, Inc. Prior to joining Vickers, he directed engineering efforts for such major projects as the second stage liquid rocket engine for the "Discoverer" program and attitude control rocket systems for "Project Mercury" and the X-15 airplane.

P. J. MAZZIOTTI has been named manager of research and development at Dana Corp. He had served them as chief engineer of Universal Joint Division since 1953.


Cummings


Lee


Crawford


Hoekstra


Michell


Chao

F. B. SELENSKY has accepted leadership of the Product Analysis Department at John Deere Dubuque Tractor Works. In this capacity he will report directly to the manager.

Selensky recently retired as chief engineer of Current Product Design at John Deere Dubuque, at his own request and for personal reasons.

RUSSELL CANDEE has been named to succeed **F. B. Selensky** as chief engineer of Current Product Design at John Deere Dubuque Tractor Works. Candee joined John Deere Waterloo Tractor Works in 1941 as engineer. Prior to his recent appointment he was project engineer at John Deere Waterloo Engineering and Research Center.

HOWARD L. WILLETT, Jr., president, Willett Truck Leasing Co., is credited with major contributions to progress of the 91-year-old company in "Willett and the March of Time," ... an unusual book written by his unusual father, Howard L. Willett, Sr. First mention of Howard junior runs like this:

"1932, Howard, Jr. . . . third generation . . . graduates from Harvard Business School. Reorganizes garage . . . introduces night repair . . . preventive maintenance. Introduces helpful cost accounting and even a chemist. Starts a school for driving and double-clutching."

This privately printed and circulated volume tells the 91-year history of the Willett Co. and the Willett family . . . tells it in exciting telegraphic language rarely if ever seen or heard in such a volume. Willett, Sr. — not an SAE member — is still chairman of the board. President Howard, Jr. is a past SAE Director and has been a member since 1935.

WILLIAM L. PRINGLE has been appointed president of Chrysler Corp.'s Marine and Industrial Engine Division.

Pringle began his career in 1937 with Timken Axle Division of Rockwell-Standard Corp. and served them in various engineering and sales positions. In 1955 he joined Long Mfg. Division of Borg-Warner Corp. as director of sales. The following year he became director of engineering. In 1957 he left Borg-Warner to assume his most recent position as director and president of Hercules Motors Corp.

WALTER J. SPENGLER has retired as director of engineering at Scintilla Division, Bendix Aviation Corp., after nearly 37 years service.

In the company's early years, Spengler supervised the hiring of personnel in addition to functioning as a one man engineering staff. When an engineering department was established within the Division, he assumed charge of the department and has maintained the position since. He will continue to serve as a consultant to Scintilla.

STEPHEN E. GREGOIRE succeeds **Walter J. Spengler** as director of engineering at Scintilla Division, Bendix Aviation Corp. For the past year he has been assistant director of engineering.

Gregoire joined the Division in 1939 as designer and served them subsequently as design engineer, project engineer, senior project engineer, assistant chief engineer and chief engineer in charge of Jet Ignition Group.

HAROLD L. BROCK has been director of engineering research at John Deere Tractor & Research Center, Waterloo, Iowa, since the retirement of **Wayne Worthington** from that position late last year. He had been assistant director of engineering research since April 1959. Brock, a past SAE Director, was associated with Ford tractor engineering for many years, becoming Ford's chief tractor engineer in 1940.

J. L. ATWOOD, president of North American Aviation, Inc., recently received the American Society for Metals' 1959 Medal for the Advancement of Research.

In making the presentation, ASM president Dr. H. C. Lorig stated that it was given to North American for the company's "constant endeavors on behalf of research and keen foresight in gauging the needs of aircraft and missile technology."

RAYMOND T. ZWACK has joined The Liquidometer Corp. as manager of industrial products and systems development. Previously he was manager of Development Engineering Division of Solar Aircraft Co.

Stoll

Fontaine

GEORGE E. STOLL has been elected an executive vice-president of Bendix Aviation Corp. He will be responsible for direction of 24 U. S. divisions and subsidiaries, with headquarters in Detroit.

Stoll joined the company in 1929. He became a member of the administration committee in 1947 and was elected a vice-president in 1949. He has been a director since 1950. In 1952 he was appointed a group executive in charge of eight automotive and Midwest divisions, a post he has held until now.

A. P. FONTAINE has been elected an executive vice-president at Bendix Aviation Corp. He will be responsible for engineering and research, sales, planning, product development, and patent activities.

Fontaine has been associated with the aviation industry for 29 years. In 1954 he was named director of engineering at Bendix and became a vice-president and member of the administration committee the following year. He was elected a director in 1959.

VICTOR T. CARBONE has become vice-president and manager of Mitchel Camera Corp. In this capacity he will be concerned with overall management of the company and the newly formed Airborne Components Division. He was previously division manager at Fairchild Controls Corp.

— continued —

Mazziotti

Pringle

Spengler

Gregoire

Brock

Zwack

SAE Father and Son

MILES A. TOWNSEND (left), who joined SAE in 1959 is shown with his father, **F. D. TOWNSEND,** a member since 1944. The senior Townsend is general manager of Western Washer & Stamping Co., a subsidiary of The Seng Co. Previously western sales manager for Houdaille Industries, Inc., he obtained his present position during 1959. Miles A. Townsend is project engineer in advanced development at Sundstrand Aviation Corp. He graduated from the University of Michigan in 1958 and is now taking advanced engineering courses at the University of Illinois to complete requirements for masters degree.

FREDERICK J. GUNTHER has been named product manager of Marine Engine and Public Works Division of Waukesha Motor Co. After serving as an instructor of Automotive Engineering at Purdue University, Gunther joined Waukesha Motor Co. in 1940. He has served in various capacities in the Sales Department, and recently concentrated his activities to sales and applications of the Marine and Public Works markets.

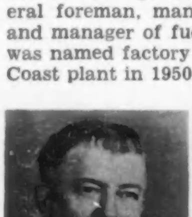
H. H. WIEDENMANN, general production manager of U. S. and Canadian tire plants at Firestone Tire & Rubber Co., has been elected vice-president for tire production.

Wiendenmann has served the company as a production employee, member of development department, general foreman, manager of tire plant, and manager of fuel cell division. He was named factory manager of Pacific Coast plant in 1950, manager of Akron tire plants in 1952, and production manager of North American tire plants in 1954.

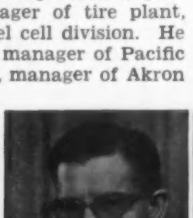
J. HOWARD DUNN, formerly manager of Sales Development Division, is now manager of Process Development Laboratories for Aluminum Co. of America. Dunn is chairman of SAE Engineering Materials Activity Committee and a member of SAE Membership Committee.

GALE W. PORTER has been named managing engineer for special projects at Chrysler Corp.'s Dodge Division. Porter joined Dodge in 1956, after six years on the engineering staffs of two other automobile manufacturers.

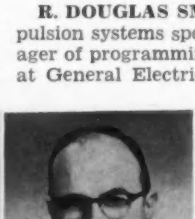
R. DOUGLAS SMITH, formerly propulsion systems specialist, is now manager of programming and requirements at General Electric Co.



Gunther



Wiedenmann



Dunn

Porter

W. ARTHUR FLETCHER has been named to the newly created post of staff engineer in charge of advanced engineering, responsible for development of new and advanced processes at General Motors Corp.'s Process Development Section.

Previously he was director of facilities and services for Diesel Equipment Division. He was first employed by Chevrolet Flint Division in 1926 and two years later transferred to Delco-Remy Division as junior engineer. In 1951 he became Delco-Remy's chief process engineer, serving until his assignment to Diesel Equipment in 1956.

CHARLES C. RAYMOND has been named quality control manager at Eaton Mfg. Co.'s Pump Division. Raymond joined Eaton's Pump Division in 1948 as draftsman. He served them most recently as sales engineer at their Detroit office.

M. BURTON EASTER has been appointed sales engineer at the Detroit office of Eaton Mfg. Co.'s Pump Division. Previously he was application engineer at Vickers, Inc.

HARRY J. SCOTT has joined the Pump Division of Eaton Mfg. Co. as chief engineer for advanced engineering. Previously he was employed by Borg-Warner Corp. as manager of Detroit Sales office, Pesco Products Division.

JOHN J. CARLIN, JR. has been appointed sales manager of Clevite Harris Products, Inc. He will direct the company's sales activities in the auto, truck, appliance, marine, and off-highway equipment industries.

Carlin joined the company in 1950 and has been district sales manager in Chicago for the past four years. Prior to that he was product engineer.

He is a member of the board of governors of SAE Chicago Section.

JOHN H. NORTON has become engineering assistant to product manager, Surface Armament Division at Sperry Gyroscope Co. In this capacity he will be concerned with Sperry's FPS-35 Air Search Radar System.

Previously research engineer at North American Aviation, Inc., he was active in organization of the engineering liaison system for their X-15 Project.

T. G. DREWES has been appointed sales engineer at Raybestos-Manhattan, Inc., Equipment Sales Division. Formerly he was sales engineer with American Brakeblok Division, American Brake Shoe Co.

WILLARD C. COX is now manager of manufacturing engineering department at Ford Motor Co.'s St. Louis assembly plant. Formerly he was supervisor of manufacturing engineering section at the company's Mercury Station Wagon plant.

WILLIAM EDGAR JOHN, president of William Edgar John & Associates, Inc. of Rye, N. Y., has been elected president of the American Boat & Yacht Council.

E. D. REEVES has become vice-president and director of Humble Oil & Refining Co. Previously he was executive vice-president at Esso Standard Oil Co.

JOHN H. GEBO has been appointed to the newly created position assistant chief engineer, automotive bearings at General Motors Corp.'s Hyatt Bearings Division.

Formerly Gebo was product engineer in engineering department of Chevrolet Gear and Axle Division.

He joined Chevrolet as a college Graduate trainee and after various engineering responsibilities, was appointed assistant resident engineer at Gear and axle plant. In 1956 he became resident engineer.

JOHN F. MOULT, JR. has assumed new duties as assistant chief engineer, design, research and development at Hyatt Bearings Division, General Motors Corp.

He has extensive experience at Hyatt as laboratory test engineer and project engineer. In 1956 he was named assistant chief engineer, aircraft bearings and held this post until his recent appointment.

GEORGE T. ANSEN, supervisor of field operations for Chrysler Corp.'s Defense Engineering organization, left the company during the month of February to take charge of a U. S. government-sponsored automotive equipment exhibit at the International Trades Fair, Bombay, India. The exhibit was designed to interest India's tradespeople in developing local automotive service and maintenance shops.

GEORGE A. ZINK has been appointed director of process development for Defense Systems Division of General Motors Corp. Zink joined GM Allison Division in 1929 as engineer. He served them successively as metallurgist, superintendent of bearing plant and assistant to general manager.

In 1943 he became works manager at Detroit Diesel Engine Division. In 1952 he became general manager, Fabricast Division, a post he held until the Division was recently consolidated with Central Foundry Division. Subsequently he was manager of Bedford, Ind. and Jones Mills Ark. plants of Central Foundry Division.

PERCY A. WOOD has become assistant vice-president in charge of engineering and maintenance for United Air Lines. Formerly he was manager of engineering planning at the Municipal Airport in San Francisco.

HARRY G. SCHWAB has been appointed director of manufacturing at Bunting Brass & Bronze Co. He will be responsible for the Toledo and Kalamazoo operations of the company. He has been employed by the company for 20 years and has served them successively as metallurgical assistant, metallurgist, foundry superintendent and plant superintendent.

WILLIAM A. THOMAS, formerly automotive products representative at Detroit for Goodyear Tire & Rubber Co., is now account executive in charge of the company's new Cincinnati office. In this post, he will be responsible for serving original equipment manufacturers in Southern Ohio, Southern Ind., Kentucky, and West Va.

W. W. VYVYAN has been named manager of product design for Ryan Aeronautical Co. Previously he was chief of power plant section at the company's Lindberg Field, San Diego. Vyvyan is vice-chairman of SAE San Diego Section.

DONALD H. MONSON has been appointed works manager of American Motors Corp.'s Kenosha plant.

Monson joined Nash-Kelvinator in Kenosha in 1940 as time-study engineer and became process engineer the following year. In 1945 he joined Chevrolet's light car division and returned to Kenosha in 1947 as special assignment engineer.

He was appointed assistant chief inspector in 1951, chief inspector in 1952, and manufacturing engineer in 1957.

HENRY KNIPPENBERG has become president of Dresser-Ideco Co., a Division of Dresser Industries, Inc. Previously he was assistant to the president.

ROY E. MARQUARDT, president of the Marquardt Corp., recently represented the company at a listing ceremony, when the company was listed on the New York Stock Exchange.

BUDD L. KEHNE has become president of D & B Supply Co. Previously he was division sales manager at Gould National Battery Co.

ANTHONY THOMPSON, previously service engineer for Jaguar Cars, Inc. at their New York office, is now serving the company as resident service engineer in San Francisco.

WILLIAM G. ANDREWS, formerly regional service engineer, is now manufacturer service representative for Cummins Engine Co., Inc.

SETH GIBSON has joined Pratt & Whitney Aircraft Division of United Aircraft Corp. as experimental engineer. Formerly Gibson was a student at Swarthmore College.

Schwab

Thomas

Vyvyan

SAMUEL E. ROGERS has become senior mechanical engineer at the D. C. Section, Drives Division, Louis Allis Co. Formerly he was project engineer for engine driven welders at Lincoln Electric Co.

Obituaries

L. C. BUEHLER . . . (M'27) . . . vice-president and treasurer, Indiana Gear Works . . . died December 11 . . . born 1883.

LEE MILTON CLEGG . . . (M'24) . . . retired as vice-president and director of Thompson Products Division, Thompson-Ramo-Wooldridge, Inc. . . . died January 5 . . . born 1897.

LELAND W. FOX . . . (M'34) . . . consultant . . . retired as manager of Field Engineering Division, Development Department, Firestone Tire & Rubber Co. . . . died December 9 . . . born 1894.

B. FRANK JONES . . . (M'30) . . . consultant . . . retired as chief engineer, White Motor Co. . . . died January 8 . . . born 1891 . . . past chairman SAE Cleveland Section . . . past SAE director.

EARLE S. MacPHERSON . . . (M'16) . . . retired as vice-president of engineering at Ford Motor Co. . . . consultant in development of Ford Falcon . . . died January 26 . . . born 1890 . . . past chairman of SAE Technical Board.

DANIEL ROESCH . . . (M'16) . . . retired professor emeritus, automotive engineering . . . consultant . . . died January 16 . . . born 1882.

ROY W. ROUSH . . . (M'44) . . . consultant for Rockwell-Standard Corp. . . . died January 24 . . . born 1894 . . . had been active on SAE War Engineering Board and SAE Iron and Steel Technical Committee . . . chairman of SAE Engineering Materials Activity in 1950.

. . . Rambling

Through The Sections

ADVANTAGES OF AIR SUSPENSION for trucks and trailers are: better ride possible, constant frame height can be maintained with various loads, weight saving (partially cancelled by required torque and positioning arms), gauges can be mounted on dash to show loading and indicate tire trouble, load transfer is possible, and load points may be distributed on frame, according to A. D. McLean and G. R. Giberson of Kenworth Motor Truck Co., who spoke at **Southern California Section** January 11.

Alfred Bandi (left) and **C. D. Long** (right) received certificates for 25 years membership in SAE from A. H. Paton, section chairman (center) at **Montreal Section's** October meeting.

AN OPTION . . . "Any member residing outside Section territory, upon written request for assignment to membership in a given Section may be so assigned.

"Such a member can select only one Section."

The above information (pertinent to about 5% of SAE members who live outside Section or Group territory) is printed at the request of SAE Council.

Request for assignment to a specific Section or Group should be addressed to Sections Department at SAE Headquarters.

DETROIT SECTION again welcomes all papers eligible for the **Henry Ford Memorial Award.** Each year this award is presented for the best paper on a subject relating to automotive ground vehicles . . . written by an SAE member (regardless of membership grade) under 33 years of age at the time his paper is submitted in the competition.

Originality, significance of subject and conclusions, extent of research, logical organization, and clarity of writing are among the important considerations of the Award Committee.

Papers submitted need not have been presented at SAE meetings, but should be of acceptable standard for presentation at any national or Section meeting.

The Award Committee will consider any paper presented, or submitted, during the Detroit Section year of June 1 to May 31. This year's award carries a cash value of $200.

Interested members may secure copies of the Award booklet, or further information, by writing the Henry Ford Memorial Award Committee, Detroit Section SAE, Rackham Building, 100 Farnsworth, Detroit 2, Mich.

CERTIFICATES FOR 25 and 35 YEARS membership in SAE were presented at **Chicago Section** December 8 to (left to right) Judson A. Purvis for 35 years; J. W. Tierney, 35 years; Edward F. Donham, 25 years; Harry A. Knowlton, 35 years; John F. Bartuska, Jr., 25 years; Fred L. Faulkner, 25 years; Dr. Austin B. Wilder, 25 years; SAE Director Robert C. Wallace, 25 years; and Arthur F. Ochtaman for 35 years.

THE AVERAGE MOTORIST is not realizing maximum motor oil and filter performance when excessively long drain periods are used, according to the evidence found in a 56,000 mile cab fleet test in the Cleveland area.

The tests showed a definite increase in engine cleanliness with decreasing oil change interval. Appreciable quantities of sludge and varnish were found in all cabs, even when the oil drain period was 1500 miles (oil drains of 1500, 3000, and 6000 miles were employed) Robert K. Williams of The Lubrizol Corp. told **Cleveland Section** on January 18.

SIMPLIFIED RECOMMENDATIONS FOR OIL DRAIN PRACTICE, proposed by The Lubrication Committee of the American Petroleum Institute are: In the summer drain every 2000 miles or every 60 days, whichever comes first. In the winter drain every 2000 miles or every 30 days. This would provide "Mr. Motorist" excellent engine protection insurance at a yearly cost of about 1% of the cost of the car.

The difficulties of establishing such a rule where pointed out by C. C. Moore of Union Oil Co. of California at **Southern California Section** on December 14.

A statistical survey of oil change habits of motorists shows that about 18% change at 1,100 miles, down to 5% at 5000 miles, with the average about 1,925 miles. Automobile manufacturers recommend anywhere from 2000 to 5000 miles.

• • •

MAN'S ADAPTABILITY TO CAPSULATED ECOLOGY forms a well recognized problem in the development of a Space Cabin Simulator. A 5 ft by 8 ft by 12 ft elliptical cylinder forms the shell of the cabin and is completely sealed for 30 day flights, thereby making it necessary for all physiological requirements to be completely contained within the cabin, Jean R. Nelson (above), project engineer for Minneapolis-Honeywell Regulator Co., told **Twin City Section** at their father and son meeting, January 13.

Edwin J. Merrick of General Electric Co. (above, center) spoke at **Philadelphia Section's** November meeting on "Space Vehicle Design Considerations." Also present were L. F. DuMont, chairman (left) and Cadet Col. S. Schwartz, Pennsylvania Military College.

APPROXIMATELY ⅓ MORE ENERGY is obtained with today's 10 to 1 high compression ratio engine than with yesterday's 5 to 1 compression ratio James A. Hodges of Western Region Dupont Co. stated at **Hawaii Section's** January meeting.

SAE Section Meetings

ATLANTA

April 4 . . . Vince Hudacko, Metallurgical Department, John Hakkio, Group Leader, Structural Analysis, Cleveland Pneumatic Tool Co. "Metallurgical & Structural Aspects of Processing High Strength Steels." Dinner 7:00 p.m. Meeting 8:00 p.m. Special Feature: Cocktails, sponsored by Cleveland Pneumatic Tool Co.

BALTIMORE

April 14 . . . D. W. Dinsmore, assistant supervisor, Research Eng. Laboratory, Monsanto Chemical Co. "Hypoid Gear Performance & Lubrication." Engineers' Club, 6 W. Fayette St. Dinner 7:00 p.m. Meeting 8:00 p.m. Special Feature: Social Period at 6:30 p.m.

BUFFALO

April 4 . . . C. V. Crockett, chief engineer, GM Truck and Coach Co. "Reliability — A New Engineering Challenge." The Party House, 677 Beahan Rd., Rochester. Dinner 6:30 p.m. Meeting 8:00 p.m.
April 20 . . . Richard Figgins, Sundberg & Ferrar. Styling Plastics for Automotive Use." Hotel Sheraton, Delaware Ave. near North, Buffalo. Dinner 7:00 p.m. Meeting 8:00 p.m.

BRITISH COLUMBIA

April 18 . . . "Maintenance on Highway Trucks" to be presented at the Hotel Georgia, Vancouver. Dinner 6:30 p.m. Meeting 8:00 p.m.

DETROIT

April 4 . . . Junior Activity Meeting. "Application of Computers in Modern Automotive Design." ESD Auditorium, Rackham Educational Memorial. Meeting 8:00 p.m.
April 18 . . . Robert W. Hartwell, general manager, Power Reactor Development Co. "Atomic Energy in Industry." Commodore Perry Hotel, Toledo. Dinner-Meeting. Special Feature: Tour of Enrico Fermi Atomic Power Plant, Monroe.

INDIANA

April 28 . . . Prof. V. E. Bergdolt, Purdue University. "Nuclear Power from the Engineers' Standpoint." Purdue University. Dinner 6:30 p.m. Meeting 8:00 p.m. Special Feature: Tour of Purdue Nuclear Engineering Laboratory.

METROPOLITAN

April 21 . . . Joint F & L and Diesel Activity Meeting. E. A. V. Horiak, director of engineering, Hercules Motors Corp., Dave Viger, president, American Diesel Co., and a Representative from a Taxicab Fleet. "Diesel Engines for Light Duty Fleets and Taxicabs." Henry Hudson Hotel, 57th & Ninth Ave., Manhattan. Time 7:45 p.m.

CHICAGO

April 12 . . . K. H. Hansen, assistant director, Res. & Development Dept., Chevrolet Motor Division, GMC. "The Chevrolet Convair." Knickerbocker Hotel. Social Half-Hour 6:15 p.m. Dinner 7:00 p.m. Meeting 8:00 p.m.

MID-CONTINENT

April 20 . . . Joint Section and

SAE Section Meetings

— continued —

Oklahoma University Student Branch Meeting. Oklahoma University Campus. Meeting 7:30 p.m. April 29 . . . Ladies Day Meeting. Rolling Hills Country Club, Tulsa. Social Hour 6:00 p.m. Dinner 7:00 p.m. Meeting 8:00 p.m.

MONTREAL

April 18 . . . Tour of the T.C.A. Overhaul Base at Dorval Airport. Short talk on "The T.C.A. DC8 Jet Aircraft." Dinner-Meeting 7:00 p.m.

NORTHWEST

April 8 . . . Northwest Round Robin by Portland Section. Sponsored by Mack & White Motors. "Highway Truck Maintenance." Stewart Hotel, Seattle. Dinner 6:30 p.m. Meeting 8:00 p.m. Special Feature: Movie.
April 22 . . . Special Airline Operational Meeting, Seattle. Theme of four session meeting to cover Airline Communications, Dispatching and Scheduling, Jet Reliability, Helicopter Interchange Possibilities, etc.

PHILADELPHIA

April 6 . . . D. P. Heath, Socony Mobil Oil Co. "Symposium on Fuels and Lubricants Problems." F. J. Woechan, U. S. Post Office. "Symposium on Fleet Maintenance Problems." Madison House, Presidential Apartments. Afternoon Meetings 2:00 p.m. to 5:00 p.m. Dinner-Meeting — Cocktails 6:00 p.m. Dinner 6:30 p.m. Meeting 7:45 p.m. Special guest SAE President H. E. Chesebrough.

ROCKFORD-BELOIT

April 11 . . . Plant Tour. Chevrolet-Fisher Body, Janesville, Wisconsin. Dinner 6:00 p.m. Plant Tour 6:45 p.m.

SAE Central Illinois Section's 11th Annual

EARTHMOVING INDUSTRY CONFERENCE

APRIL 5-6, 1960

PERE MARQUETTE HOTEL, PEORIA, ILL.

● Tuesday morning, *April 5* . . .

"The Needs of the Corps of Engineers in Earthmoving Machinery"
Lt.-Gen. E. C. Itschner, *United States Army*

"The A.A.S.H.O. Road Test Technicalities"
W. E. Chastain, Sr., *A.A.S.H.O. Road Test*

technical chairman — E. E. Isgren
LeTourneau-Westinghouse Co.

● Tuesday afternoon . . .

"Future Trends in Electrical Systems"
W. C. Edmundson, *General Motors Corp.*

"Role of Computers in Earthmoving"
Basil Mikhalkin, *Bendix Aviation Corp.*

technical chairman — D. W. Erskin
Allis-Chalmers Mfg. Co.

● Wednesday morning, *April 6* . . .

"The Use of Turbines in Earthmoving Equipment"
L. J. Nuttall, *General Electric Co.*

"The Fuel Cell Power Plant"
Dr. H. K. Ihrig, *Allis-Chalmers Mfg. Co.*

technical chairman — W. J. Lux
Caterpillar Tractor Co.

● Wednesday afternoon . . .

panel discussion — "Earthmoving Equipment Requirements for the Next Decade"
participants not yet finalized

technical chairman — D. K. Heiple
LeTourneau-Westinghouse Co.

General Motors Reliability in Action...

Polar Test!

Heater test in the Harrison cold tunnel. Car is rotated on turntable to expose every angle to frigid wind blasts.

HARRISON Heaters Undergo Biting Below-Zero Tests in Cold Tunnel!

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Briefs of SAE PAPERS

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Status Report on Gear Lubrication, T. W. HAVELY. Paper No. S225. Review of published literature on gear lubrication. Paper covers: lubrication requirements of gears; lubricants for gears; and testing of gear lubricants.

GROUND VEHICLES

Some Problems of Spark Plug Operation in Two-Cycle Engines, L. R. RENTZ, R. F. NOSTRANT, R. J. CRAVER. Paper No. 123V. Review of present large outboard engine spark plug requirements, as determined by engine manufacturers' reports and Champion Technical Service Department reports and laboratory investigations; attempt made to relate engine output, certain engine operating variables, and test procedures to spark plug performance and spark plug insulator tip temperature.

Origins of Diesel Engine Noise, A. E. W. AUSTEN, T. PRIEDE. Paper No. 125T. First part of study reported: effect of engine speed load and size (swept volume) on noise evaluated on limited range of engines; total sound intensity (but omitting l-f components due to air intake noise) varies as (speed)^3, as (swept volume) 4/3 and very little with load; noise from petrol engine was of same order of magnitude as that of diesel engines at full load but considerably less at low load; sources of noise and means of reducing them.

Physical and Chemical Ignition Delay in Operating Diesel Engine Using Hot-Motored Techinque—Part 2, C. W. CHIANG, P. S. MYERS, O. A. UYEHARA. Paper No. 125U. Extension and continuation of work previously described and indexed in Engineering index 1956 p. 269; by comparing three pressure-time records obtained in present study, rates of vaporization and of chemical reaction can be determined during ignition delay period in operating diesel engine; such data are shown for different fuels and operating conditions; estimations made of penetration and temperatures existing in spray.

New Oil Seal Designs for Truck and Bus Engines, S. M. LILLIS. Paper No. 119T. Heavy duty engine problems involving front crankshaft and rear crankshaft seals, with more emphasis put on latter because they present more varied conditions in each individual application; new oil seal designs illustrated, and their features and function described, followed by performance examples.

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Briefs of SAE PAPERS

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Transmission Oil Seals, G. L. CORSI. Paper No. 119U. Characteristics of silicone, polyacrylic (PA-21) and butyl acrylic (BA-21) high temperature materials employed in manufacture of seals; progress in mechanical shape of oil seals, when coupled with new synthetic elastomers; advance made in technique of excluding dirt and mud; application information required by oil seal suppliers to assure satisfactory performance from selected seal.

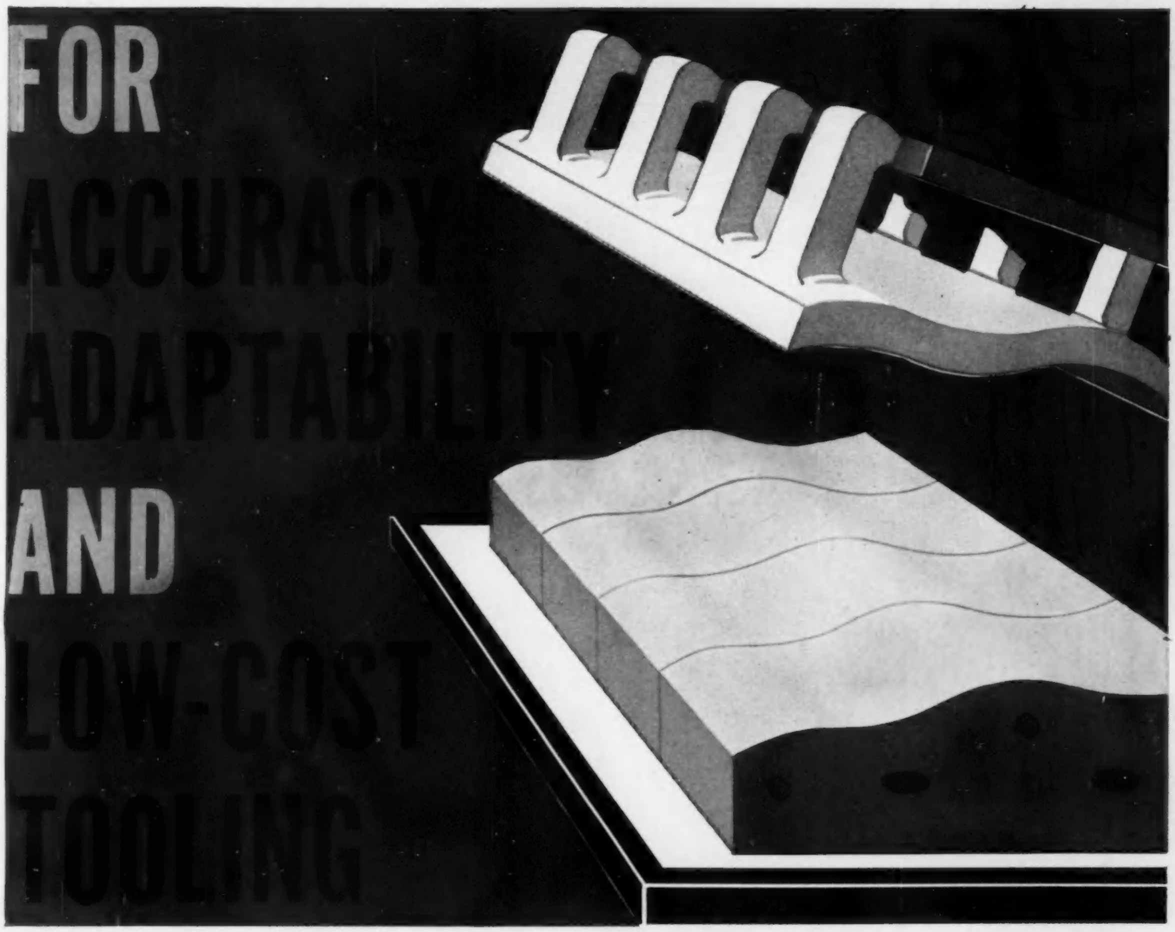
Some Recent Developments in Truck Wheel Seals, R. A. HUDSON. Paper No. 119V. Description of Unitized seal and its advantages; example of truck wheel application of external type Unitized seal; other seal applications in trucks; cost; principal significance of Unitized seal as compared with conventional oil seals is fact that responsibility for performance of seal rests entirely with oil seal vendor.

New Concepts in "Factor of Safety" Applicable in Design of Engines, C. LIPSON. Paper No. 120T. Present usage of factor of safety which varies greatly throughout field of engineering; significant factors of safety; safety factor determined from consideration of both stress and strength analysis; manner in which these two analyses are compared depends upon pattern of loading and stresses resulting therefrom; four different patterns of stress considered and method of determining factor of safety for each indicated; application to compressor bolt design.

Aluminum High-Output, High-Speed Diesel Engines, R. F. SCHAEFER. Paper No. 120U. Discussion limited to high speed types of under 6½ in. bore and over 1000 rpm; history of diesel aluminum engines; details found particularly important in designing with aluminum; cylinder block casting with its more complicated structure discussed; progress made in production of cylinder heads and pistons; increasing use of aluminum for high speed rotating parts; technical and cost advantages of using aluminum for major components of liquid cooled and air cooled diesel engines.

Design of Truck for Better Ride and Handling, H. O. FLYNN. Paper No. 121T. Aspects of appropriate chassis design described which will provide improved handling, ride and driver comfort, with increased load capacity; general discussion on concept of comfort; broad engineering approach required to attain increased comfort for personnel and cargo; detailed descrip-

continued on p. 128



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tion of specific Chevrolet approach to obtain desired increased comfort, testing, and proof of accomplishment, through special instrumentation and data evaluation.

Westinghouse Model EFG Governor Theory of Operation and Time of Response, J. E. FREDERICK. Paper No. 122T. Description of components of electric governor which is speed (frequency) regulating servo for prime movers driving generators or mechanical loads; how frequency error is detected, error signal amplified, and hydraulic actuator repositioned to correct for frequency error; examination of magnetic amplifier block; how fast governor operates; benefit of fast response; how EFG responds so fast without load sensing signal.

What Pierce is Doing in Diesel Governing Field, L. V. BRADNICK. Paper No. 122U. New GC-6905 governor is mounted on engine accessory drive and is driven from timing gear train; chief advantages of installation of this type governor are its simplicity, reliability, and accuracy of control; GC-829 and GC-3024 governors made by Pierce Governor Co.; development of new pump-mounted governor for automotive applications first model of which is GC-5600.

Controls for Today's Diesels, J. R. SHLIKAS. Paper No. 122V. Woodward LSG governors (load sensing governor) developed to help keep engine performance abreast of increasingly critical requirements; LSG-1 governor is isochronous hydraulic speed governor with work capacity of 1 ft lb; LSG-10 governor used for large engines, has work capacity of 10 ft lb and self contained oil supply and pressure pump; response time for 100% step load change is about 1/40 of sec; block diagram of LSG governor applied to alternator set shown; operation of governor and its advantages.

Isochronous Regulation of Small Engines, J. W. MORSE, P. Van De CARR. Paper No. 122W. Control system miniaturized by Curtiss-Wright Corp. to fit in small package demonstrated by two hydraulic isochronous governors described; feed back or loop stabilized system employed to achieve these isochronous governings; three elements of governor are speed sensitive control element, power output element and stabilizing element.

Spark Plug Misfiring — Mechanism Studies, H. P. JULIEN, R. F. NEBLETT. Paper No. 123T. Report of studies particularly concerned with misfiring due to lead fouling, made by Esso Research & Engineering Co.; Spark plug temperature found to be most important variable governing misfiring; quantitative measurements of misfiring obtained with new electronic misfire counter; laboratory studies on formation, composition, and properities of compounds found in spark plug deposits.

Environment of Spark Plugs in Portable Two-Stroke Cycle Engines, L. E. HAAS. Paper No. 123U. Problems of short spark plug life and runaway preignition; controlling environment in which spark plug must operate; heat cycle; duty cycle; spark plug installation; fuel-oil-air mixture; fuel composition; lubricants and lubricant additives.

The 1960 Ford Falcon — Design and Development is a 3-part paper by Ford engineers JOHN L. HOOVEN ("The Falcon Car"); EMMET J. HORTON ("The Falcon Engine"); and JOHN C. WIDMAN ("The Falcon Body"). Paper No. 140A. Gives a detailed comprehensive description of new compact car introduced by Ford in the fall of 1959. Includes cutaway illustrations of all important parts.

The Valiant — a New Motoring Concept is a 3-part paper by Chrysler engineers A. G. LOOFBOURROW ("Design Objectives"); V. M. EXNER ("Styling"); and R. M. SINCLAIR

continued on p. 131

Briefs of SAE PAPERS

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("Engineering"). **Paper No. 140B.** Outlines design objectives in terms of market and users' requirements, positions the car's styling in relation to Chrysler stylists philosophy — which "uses words and phrases like . . . the look of motion — motion that is strongly directional in regard to rear and front end styling . . . sleek, crisp lines which flow in a dart or wedge shape." Also includes description of engineering features of this new compact car introduced by Chrysler in the fall of 1959. Includes cutaway illustrations on all major elements of the design.

The Chevrolet Corvair is a 3-part paper by Chevrolet engineers K. H. HANSEN ("Origin and Development"); R. P. BENZINGER ("Engine"); and F. J. WINCHELL ("Transaxle"). Paper No. 140C. Gives a detailed description of the new compact car introduced by Chevrolet in the fall of 1959, including the engineering reasoning behind some of the more major elements of the design, such as the all-aluminum, air-cooled engine, and the first transaxle to appear on a volume-produced car in the United States. Includes charts and cutaway illustrations on all elements of the design.

Applications of Ride and Handling, F. J. HOOVEN, R. R. PETERSON. Paper No. S222. Description of design and development program of typical light vehicle in which strictest limitations of weight and cost were required to be met; car is of conventional configuration, of unitized construction and has curb weight of 2400 lb; ride rates were chosen with eye on maximum tolerable change of attitude with load; development program for fairly radical new front and rear suspension system outlined.

Demands of Tomorrow's Market, O. K. KELLEY. Paper No. S226. Discusses the role of the engineer in meeting tomorrow's market. Shows how he must work together with the stylist and the market analyst to satisfy the demands of an ever-expanding market.

High Economy of Hercules Spark Ignition Engines for Heavy Duty — Operating on LPG, E. A. V. HORIAK. Paper No. S227. Comparison of costs for typical gasoline, LPG and diesel engines, with chart showing different items which can be expressed in dollar value; fuel economy, weight and life of engines discussed; Hall-Scott series of engines designed to give most advantages for operation on LPG fuel; features that contribute towards long life of these engines.

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visually and with somewhat less definition.

Ultrasonics uses the reflected high-frequency sonic vibrations from a panel immersed in water to give a good indication of the braze continuity between the face sheets and core. A 1/1 paper reproduction is obtainable for use as a permanent record.

With **thermographic methods**, heat from some source is applied to one side of the part. The additional mass of material represented by the core and braze fillet will draw heat away, resulting in higher temperatures in the open cell areas than at the junctions. These temperature variations can be detected and recorded by infrared photography or heat-sensitive film.

The **zinc hot-shot tester** induces thermal stresses into a local area, which will cause failure of an unsatisfactory braze.

In **radioisotopic inspection** of brazed panels, the brazing alloy is tagged with a suitable short-life, radioactive isotope. After brazing, sensitive film is placed against the outside of the part and exposed by radiations from the radioactive brazing alloy.

Serving on the panel which developed the information in this article, in addition to the panel secretary, were: chairman **D. D. Warner**, Norair — Northrop; **Wayne E. Dickinson**, Solar Aircraft Co.; **J. E. Rose**, North American Aviation, Inc.; **David F. Berry**, Lockheed Aircraft Corp.; and **Michael Watter**, The Budd Co.

(This article is based on a report of one of 16 production panels on missiles and aircraft subjects. All 16 reports are available as a package as SP-329. See order blank on p. 6.

Ceramic Coatings Promise Improved Engine Operation

Based on report by secretary

HAYDEN W. INGALLS

Solar Aircraft Co.

ADVANCES in the technology of flame spray and plasma spray as processes for applying ceramic coatings have opened new potentials for such coatings to improve operation of diesel engines, with promise of like improvements in gasoline engines.

Analysis of the mechanics of these processes leads to the conclusion that during the initial passes, the molten ceramic globules are chilled as they impinge on the cool surface of the workpiece and bond in tension. The subsequent layer, overlapping the first, goes into compression. The end result is a coating characteristized by high thermal shock resistance even in thicknesses up to seven mills, as demonstrated by cyclic quenching from 2200 F in ambient Hg with no deleterious effects.

There is a two-fold approach, one utilizing ceramics of the general formula MO_2, the other involving oxygen-deficient ceramics. Both provide the primary requirement of thermally insulating the wall of the combustion chamber. Early data indicate that the first mentioned coatings, exemplified by thoria and zirconia, increase the efficiency of the combustion process by discouraging the formation of carbon and varnishes.

Of primary interest is the novel possibility that the second class of coatings, exemplified by ceria, act as a catalyst, promoting an increased rate of combustion and thus substantially decreasing the amount of incomplete products of combustion in the exhaust. The implication is that use of this class of coatings may play an important part in minimizing the smog problem presently confronting such cities as Los Angeles.

Although there is not sufficient

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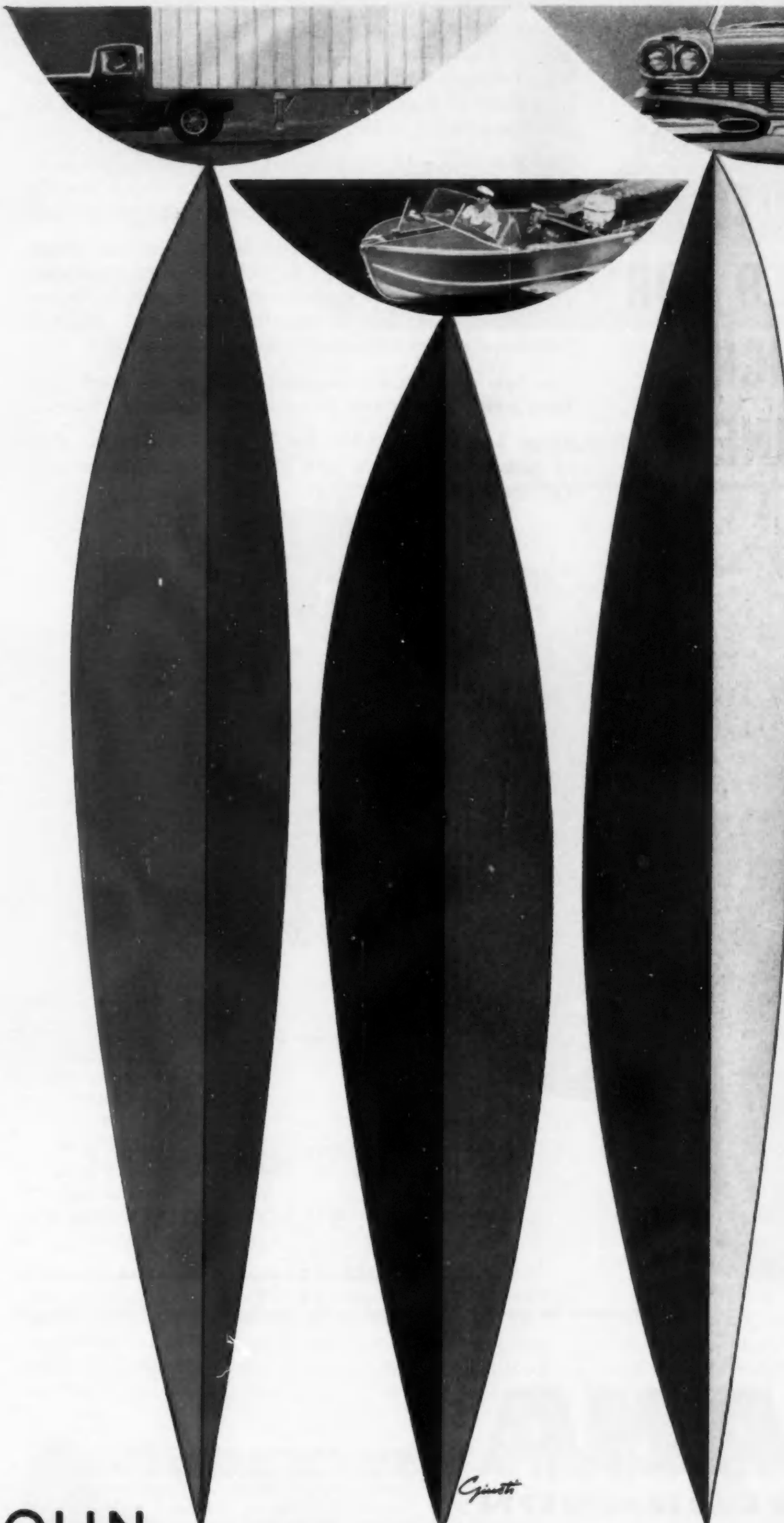

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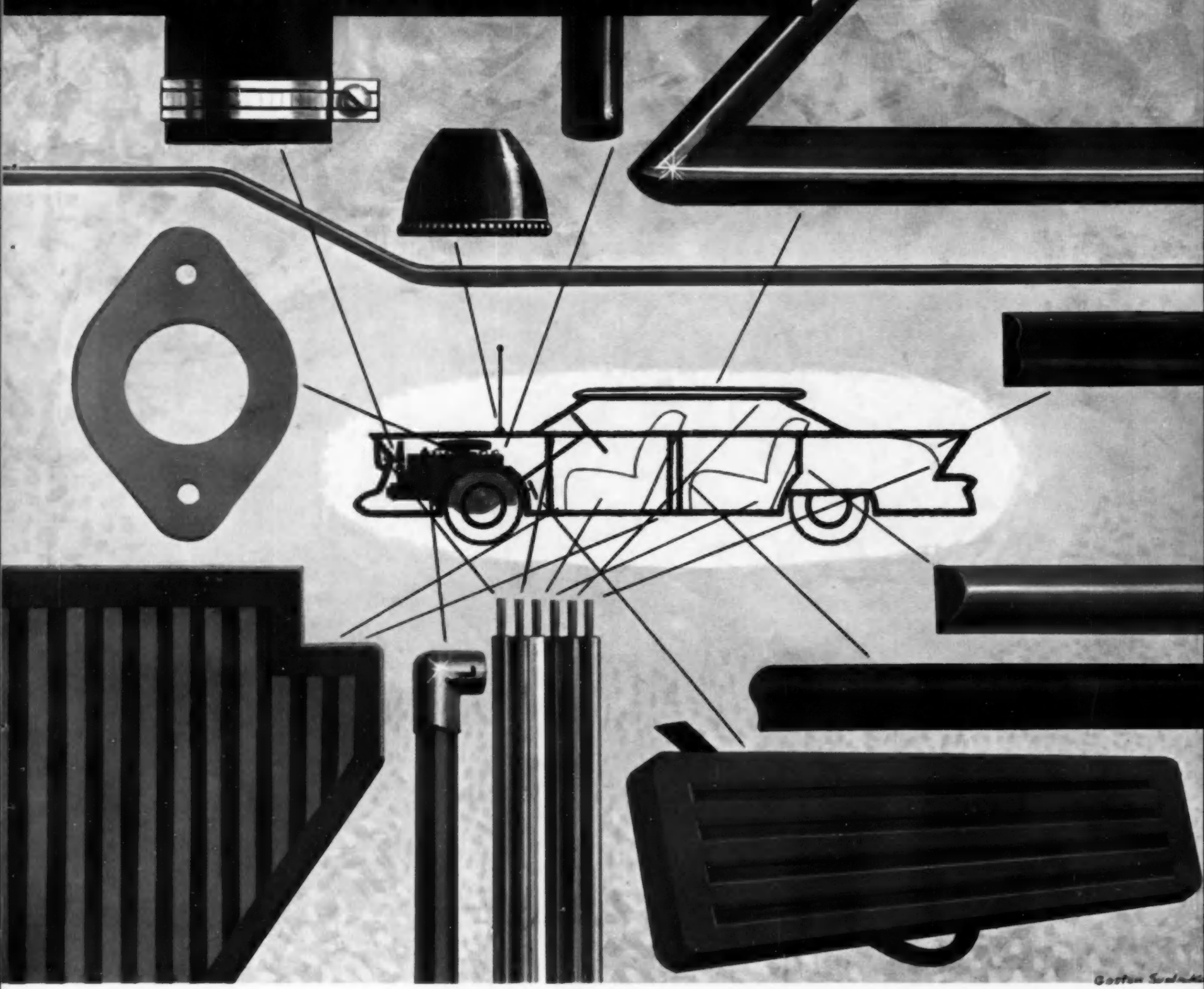

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continued from p. 132
knowledge to allow more than a conjecture as to why, the fact remains that efficiency is increased.

Serving on the panel which developed the information in this article, in addition to the secretary, were: **John V. Long**, Solar Aircraft Co. (chairman); **Samuel Sklarew**, Marquardt Aircraft Co. (co-chairman); **Alvin R. Stetson**, Solar Aircraft Co.; **Maurice Commanday**, Chromizing Corp.; **A. V. Levy**, Hughes Tool Co.; **Samuel W. Bradstreet**, Armour Research Foundation; **Don Leeds**, Space Technology Laboratories; **Herbert S. Ingham**, Metallizing Engineering Co.; and **Hugh C. Sullivan**, Convair.

(This article is based on a report of one of production panels on aircraft production subjects. All 16 are available as a package as SP-329. See order blank on p. 6.)

New Governor Gives Snappier Speed Control

Based on talk by

S. D. POLLOW

Lauson Engine Division, Tecumseh Products

(Presented before SAE St. Louis Section)

TO get closer control of engine speeds and faster response to load variations, Lauson has switched from the air vane to the mechanical or flyball type of governor for its portable engines.

Governor response cannot increase horsepower, but it makes the power more usable. The flyball governor has a maximum droop factor of 400 rpm from no load to full load, whereas the air vane governor droops from 800 to 1000 rpm. The flyball type has other advantages. It is positive in action, and unaffected by dirt, cross winds, or tilt on steep inclines.

Free-Piston Engine Powers Air Conditioner

Based on paper by

J. H. McNinch,
D. G. Mark and R. J. McCory

Battelle Memorial Institute

DIRECT fuel injection and a proximity ignition system are employed with a free-piston refrigerant compressor developed to provide a low-cost, residential air conditioning unit fueled by natural gas. The single-piston configuration, having a combustion chamber at one end and a compressor at the opposite end, was chosen because it promised simplicity, a low noise level, and long life.

Fuel economy, safety, and satisfac-
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tory starting dictated the use of direct admission of fuel into the combustion chamber. It permits complete separation of gas and air until the combustion chamber is isolated from the exhaust system and no raw gas is passed to the exhaust system. A fuel charge is obtained on the starting stroke, therefore, no priming or cycling is necessary. The one-stroke starting simplifies the starting system because it can be a one-shot device at relatively low power requirement.

Although direct ignition of a gaseous fuel presents difficult problems, the fact that the free-piston refrigerant compressor is essentially a constant-speed, constant-load device is a real advantage. No attempt is made to modulate the fuel delivered during each injection process, nor is the air supply to the engine modulated. During all modes of operation, full charges of fuel and air are used and, rather than modulating the output of the compressor, the unit is turned on or shut off as required by the cooling load.

Three factors are important to the successful operation of the fuel-injection system. First, the pneumatic-actuation system must be designed to obtain the highest possible pressure differential for injection. Second, the gas pump diaphragm must have proper response characteristics and high durability. And last, the gas-injection valve must be capable of producing a good distribution of gas throughout the combustion chamber.

Proximity Ignition System

Piston position determines spark timing in the proximity ignition system. The spark is initiated when the ground electrode situated on the piston head is brought into close proximity with the insulated electrode located in the cylinder head, the latter being energized with a suitably high electric potential. The system has several advantages in a free-piston engine. The spark timing is controlled directly by piston position without relying on any auxiliary timing devices such as breaker points. Moreover, the ignition source is located well down into the combustion chamber, thus promoting smooth, even combustion and reducing a tendency for the plug to foul. The entire system, including the power supply, is simple and inexpensive.

The electrical potential on the stationary electrode can be alternating or direct current. If alternating, a high enough frequency must be used so that, as the gap closes, the time interval until the next voltage peak will not cause a serious ignition delay. Certainly, 60-cps-line frequency is much too low. An alternating potential of any other frequency would need to be generated specifically for this purpose. And, since an a-c system must be capable of supplying energy at the peak power rate, the equipment required would be large and expensive. If the energizing po-

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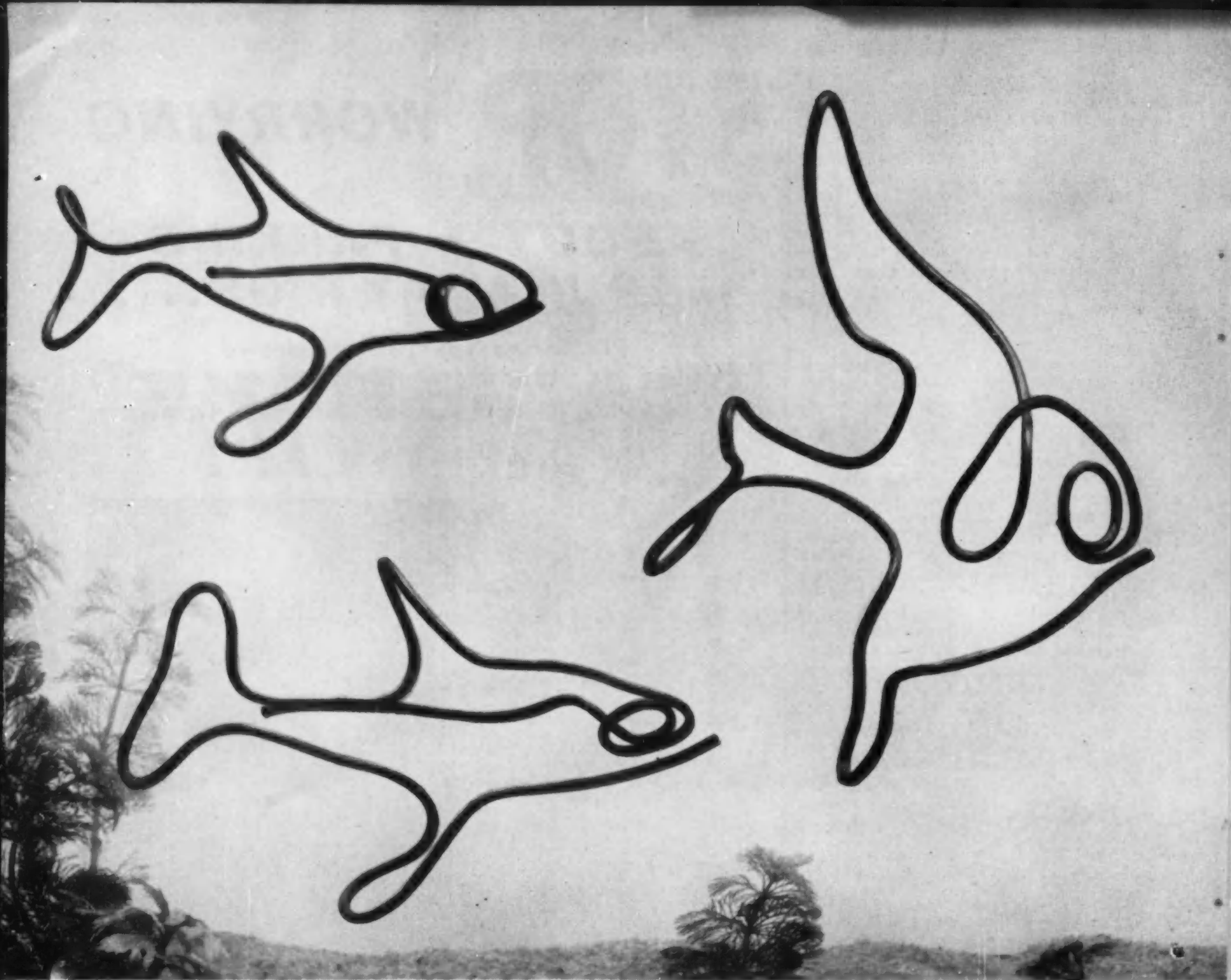

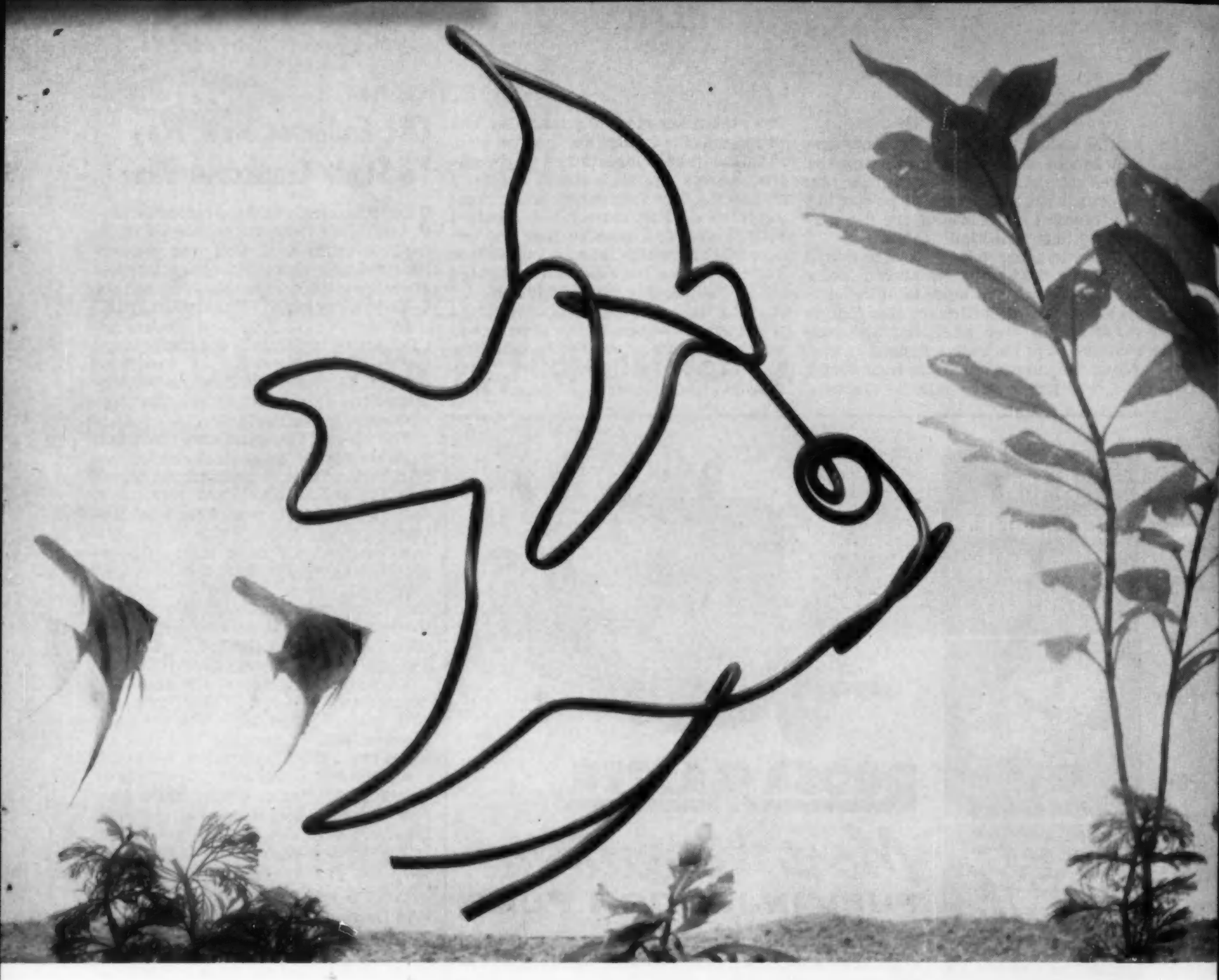

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tential is direct, an energy-storage system can be used, thus simplifying the power supply. The free-piston engine has run with both types of power, but the inherent simplicity of the d-c system led to its selection.

The operating voltage is determined largely by the gap length and the compression ratio. Its upper limit depends on ability of the stationary electrode to resist arcing over when hot and surrounded by partially ionized gases. When the engine is cold, at least 8000 v are required to give reliable starting. The stationary electrode insulator will withstand this voltage easily when cold. If this voltage is maintained as the engine warms up, it becomes excessive and arcing over to ground occurs, causing misfire. Fortunately, the required voltage also decreases so that the engine will run when hot at about 4000 v. Various means have been investigated for automatically compensating for starting and running conditions, and slight modifications of the basic power supply have been found to be effective.

To Order Paper No. 126B . . .
on which this article is based, see p. 6.

CRC Endorses New Way To Study Crankcase Oils

STEPS leading to CRC's recommendation that Designation L-38-559 be used to study oxidation and copper-lead bearing corrosion characteristics of engine crankcase oils, instead of L-38-357, appear in CRC Report 335.*

In developing the new technique, CRC set up seven test programs using the L-38-357 technique or variations thereof. A total of 24 laboratories submitted the data on which the CRC recommendation is made.

The L-38-559 technique, resulting from the test program, includes the use of a low surface temperature oil heater and controlled crankcase ventilation (off-gas rate). It was found to provide:

- Greater severity in terms of copper-lead bearing weight loss and used oil viscosity increase for a reference oil containing 70% REO-7 in an REO-7, REO-12 blend than was obtained with CRC Designation L-38-357 for a reference oil containing only 55% REO-7.
- Greater bearing weight loss discrimination between REO-7 and the 70% REO-7 blend than was obtained between REO-7 and the 55% REO-7 blend using CRC Designation L-38-357.
- Improved repeatability and reproducibility of bearing weight loss results over those provided by CRC Designation L-38-357.

The tests also revealed that variations in:

(1) The structure (batch) of copper-lead bearings can provide variations in the level of bearing weight loss for a given oil.

(2) Crankcase ventilation (off-gas rate) affect the level of bearing weight loss and oil oxidation. In general, the severity increases with increased off-gas rate.

CRC 335 further recommends that:

- A technique be set up for engine calibration of copper-lead test bearing batches.
- The ability of the L-38 technique to rate commercial oils in the order of their known performance be investigated.
- Consideration be given to simplifying the operational and equipment aspects of the L-38 technique.
- The repeatability of results in individual engines, and the reproducibility of results among engines in each laboratory, be established.
- The means of increasing the level of oil oxidation and engine deposits be investigated.
- A statistical program be carried out to establish the discriminating ability of the L-38 technique.

To Order CRC Report 335 . . .
on which this article is based, see p. 6.

* "Development of Research Technique for Study of the Oxidation Characteristics of Crankcase Oils in the CLR Oil Test Engine."

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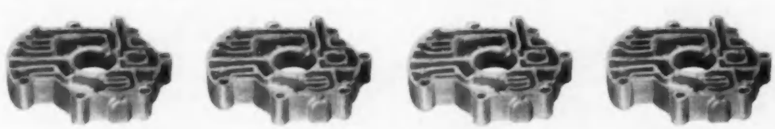

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New Members Qualified

These applicants qualified for admission to the Society between January 10, 1960 and February 10, 1960. Grades of membership are: (M) Member; (A) Associate; (J) Junior.

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Baltimore Section: Michael W. Payst (J).

British Columbia Section: Roy L. Larson (A), Ronald Gordon MacKenzie (A).

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continued on p. 146

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P-1

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Mid-Michigan Section: Benjamin Carter Benjamin (J), Harold M. Bergdolt (J), Elmer E. Braun (M), Thomas Joseph Culhane, Jr. (J), Robert Hansen (M), Bernard I. Miller (M), Richard W. Morris (J), Juras D. Philo (M), Donald F. Richter (M).

Milwaukee Section: Robert Anthony Hall (J), Wallace H. Hinz (J), Carl F. Novotny (M), Robert G. Schindler (A).

Montreal Section: Carl Bruce Peters (A).

New England Section: Alfred J. Michaud (A).

Northern California Section: George K. Gaskell (M), Maurice O. Ireland (A), Edwin Dale Thompson (J), Warren R. Whitehead (M).

Northwest Section: Douglas Bynum, Jr. (J), Gerald Wayne Canada (J), Leonard Schroeter (M).

Ontario Section: Barry Benson (J), John Douglas Franks (A), George L. A. Palinkas (J), Kenneth Jack Schwietz (M), Gus Szabo (M), Robert V. Yohe (M).

Philadelphia Section: John P. Attiani (J), Thomas F. Bonfield (A), Robert R. Rossi (M), Hilbert L. Stevens (M), William L. Thomas (J).

Pittsburgh Section: Kenneth G. Brickner (M).

Rockford-Beloit Section: Alvin H. Anderson (M), Donald F. Kowalick (M).

St. Louis Section: Chester A. Dubowski (A).

San Diego Section: Reginald E. Stanley (M), Curtis William Tritchka (J).

South Texas Group: Satyakar Nath Agrawal (J).

Southern California Section: H. Richard Alexander (M), Stirling Edwin Babcock (M), David H. Bienert (M), Lewis William Bugenig (J), Donald Robert Buist (J), Wallace A. Burton (M), Alvin P. Cluster (M), John E. Fagan (A), Capt. Jack M. Geller (M), Raymond M. Hamada (M), Loren Hufstetler (J), William V. Lanphar (M), Bernard N. Maas (M), James C. Martin (M), Lloyd F. Mauldin (M), Edwin J. Sarge (A), John A. Skinner (M), Darrell F. Theige (J), Gene R. Ward (J), William Robert Whittaker (M), Walden M. Zittle (A).

Syracuse Section: John H. Ferguson, Jr. (M), Norman J. Oldfield (J).

Texas Section: Wilder B. Bishop (A).

Twin City Section: Charles L. Amundsen (J), J. W. Mahanay (M), Robert T. Seifert (M).

Washington Section: Robert W. Bolka (M), Major William H. Young (M).

Western Michigan Section: Glenn F. DePagter (M).

Wichita Section: Philip K. Davis (J), Paul A. Gilliland (A), Jack R. Hodges (M), Henry J. Thomas (M).

Outside Section Territory: M. C. Burr (M), Garth O. Hall (M), Herbert Arthur Jespersen (M), Norman C. Nitschke (M), Thomas W. Paulsen (J), G. G. Pins (J), J. E. Richert (J).

Foreign: Peter Bloch (M), Switzerland; Robert W. French (M), So. Africa; Carl O. Gabrielson (M), Sweden; Roberto Gregori (M), Brazil; Lt. Col. Hans M. J. Jensen (M), Malaya.

Applications Received

The applications for membership received between January 10, 1960 and February 10, 1960 are listed below.

Atlanta Section: Thomas C. Brown, Arthur E. Flock, Jr., John W. Hardison, Donald H. Putman

British Columbia Section: Frank H. C. Dean

Buffalo Section: E. Grant Pike

Central Illinois Section: Donald P. Cummins, Clarence R. Fahnestock, Thomas L. Yingling

Chicago Section: Thomas H. Cafcas, Julian L. Chalk, George J. Clark, Russell Marvin Jornd, William J. Kasper, Walter F. Klaviter, Walter F. Klima, W. H. Langhenry, Richard Hugh Malanaphy, John V. Peterson, Robert R. Reid, Carl E. Russell, Don Smith Strader

Cincinnati Section: Albert H. Dall, Walter Clifton Gorham

Cleveland Section: Donald Francis Avila, Peter J. Ghirla, C. Colmery Gibson, Wolfgang Fred Ligotke, Robert Victor Moser, William A. Parilo, Kirk M. Reid, Marion L. Snedeker, Ronald Tyminski

continued on p. 148

Applications Received

continued from p. 146

Colorado Group: Rudolf O. E. Kroeger

Dayton Section: Derrolle E. Haugen, George F. Lewton, Byron L. Watson

Detroit Section: Algirdas L. Ancevicius, Edward W. Anderson, Mehmet Kemal Bayburt, Richard Million Burke, David D. Carley, Thomas R. Cassel, Roy D. Chapin, Jr., Clifford Anders Coffey, Theodore F. Cohassey, Edward C. Cove, Keith R. Deyo, Paul D. Fadow, Lawrence R. Falzon, Kenneth Irving Goedert, Herbert L. Gordon, Alton J. Hole, Emerald Howe, Earl M. Hunter, Paul Herbert Huzzard, Marvin William Jackson, Robert F. Keefer, Jerry C. Kendrick, Grover C. Lawson, Seymour A. Lippmann, John D. Mall, John D. McBrian, John A. McClanathan, N. Paul Morgan, William S. Morrison, James N. Neumann, Gerald F. O'Callaghan, Richard E. Pfeifer, Louis D. Phillippi, John W. Polick, Robert Allen Potter, Jr., Grover S. Ramsey, Larry R. Rickard, James Bennet Robbins, George H. Robinson, George V. Rouke, Walter J. Simons, Robert J. Sitler, Scott F. Slotterbeck, Fernley G. Smith, Eugene Vincent Spanski, Ivan M. Swatman, Richard Swiatek, Duane L. TeSelle, C. Arthur Van Dell, Bernard A. Wehring, Wilson Harvey West, Maurizio Augusto Wolf, George Zambiasi, Sami F. Zawideh

Indiana Section: Donald Earl Colvill, Walter G. Fuetterer, Jr., Carl T. Hardt, Robert D. Humphrey, Richard L. Sprague, James F. Stafford, Walter A. Wolf

Kansas City Section: Gerald G. Nixon

Metropolitan Section: Frank M. Duda, Rufus Russell Evans, Mortimer J. Freistadt, William J. Moses, Henri J. Otteau, Jr., Frank Joseph Pekar, Jr., Roy Burton Power, Robert William Priebe, David M. Roney, Jr., Clarence H. Sample, Fred Schnaue, Charles O. Van Zant

Mid-Continent Section: Miguel De-Assis Villaca

Mid-Michigan Section: Winthrop Gerald Beach, T. R. Fernand, John W. Roth, Howard P. Siegel

Milwaukee Section: Richard Carl Mortensen, David H. Phillips, C. R. Rigby, John A. Strachota, Robert T. Thompson

Montreal Section: John H. Blueth, Charles Huntly Duff, Cyril Alan Randall

New England Section: Forrest F. Auld, Lt. Charles G. Simpson, Adrian E. Van Dorpe, Julien R. Weigel, Sr.

Northern California Section: John H. Blakney, Jr., Glen H. Boyd, Jack T. Guerin, Roy Harold Kettle, Leroy Simpson, William Edward Sytz

Northwest Section: William E. Dennis, Lloyd H. Stearns

Ontario Section: George Bethlendy, Robert G. Brown, Paul Ferdinand Hartz, D. B. McColm, James McGuinness, Harold Richard McKnight, Andrew Millar, Alex Shelegey, E. N. Weldon, Maurice Keith Wing

Philadelphia Section: Benedict R. Buinewicz, David E. Chapman, John B. Darrah, John A. DeLaney, John F. Pfeffer, William H. Reinhold, Jr., Jerry D. Shaw, David W. Taylor, William H. Thorpe, Paul M. Tunison

Pittsburgh Section: Lewis Z. Carey Thomas F. Hanlon, George C. Tunis, Jr.

Rockford-Beloit Section: Lynn Osborne Twedt, Harold A. Weiss

San Diego Section: LaVern Lee Smith

Southern California Section: Clifford R. Adams, Charles W. Eyres, Andrew J. Kotzar, George Frederic Leonhard, Richard R. Prothero, Donald Carl Roudenbush, Cameron W. Seitz, Jr., Kevin Timothy Shyne

Southern New England Section: Carl Leonard Broman, Francis Edward Lajoie

Syracuse Section: Theron R. Chamberlain

Texas Section: Joseph Ingram

Twin City Section: John Williams Barlass, Brent T. Harding, Harijs J. Saukants, James G. Welch

Washington Section: Clifford Horton May, John W. Sawyer

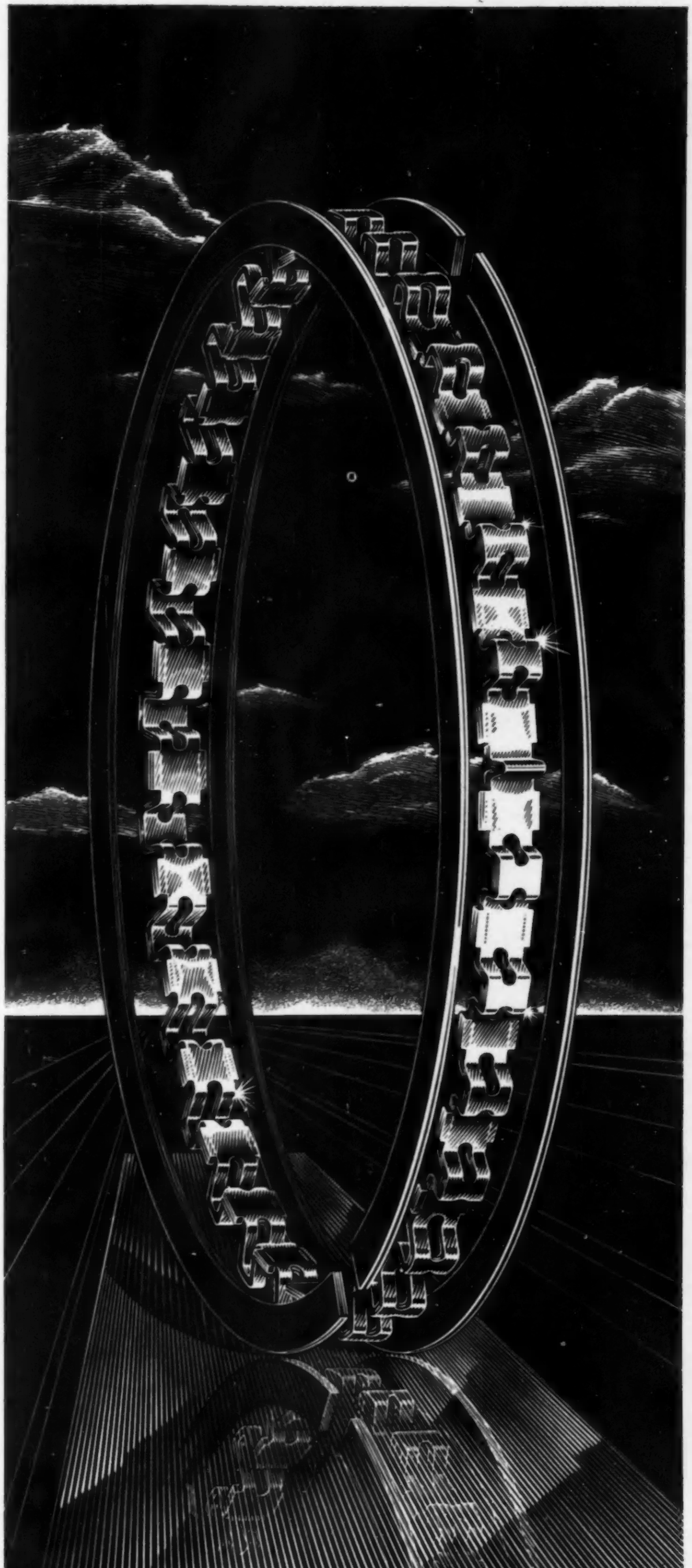
Western Michigan Section: James F. Kolbe, J. F. Oehlhoffen, Frank G. Warrick

Wichita Section: Lester Kenneth Fortney

Williamsport Group: Cornelius H. Buddenbaum

Outside Section Territory: Charles Leslie Callum, Rudolf Horsch, Thomas J. Koon, George E. Olson, Robert W. Rue, Roscoe Andrew Scott

Foreign: Donald Henry Ballard, England; Pierre Chamont, France; Daniel Del Valle Pena, Mexico; P. R. Keen, Sweden; Donald Marcus Kelway Marendaz, South Africa; Frank Will May, England; Leslie Ronald Prout, England; V. V. Srinivasan, India; S. Subbarayan, India; S. Vaidheeswaran, India



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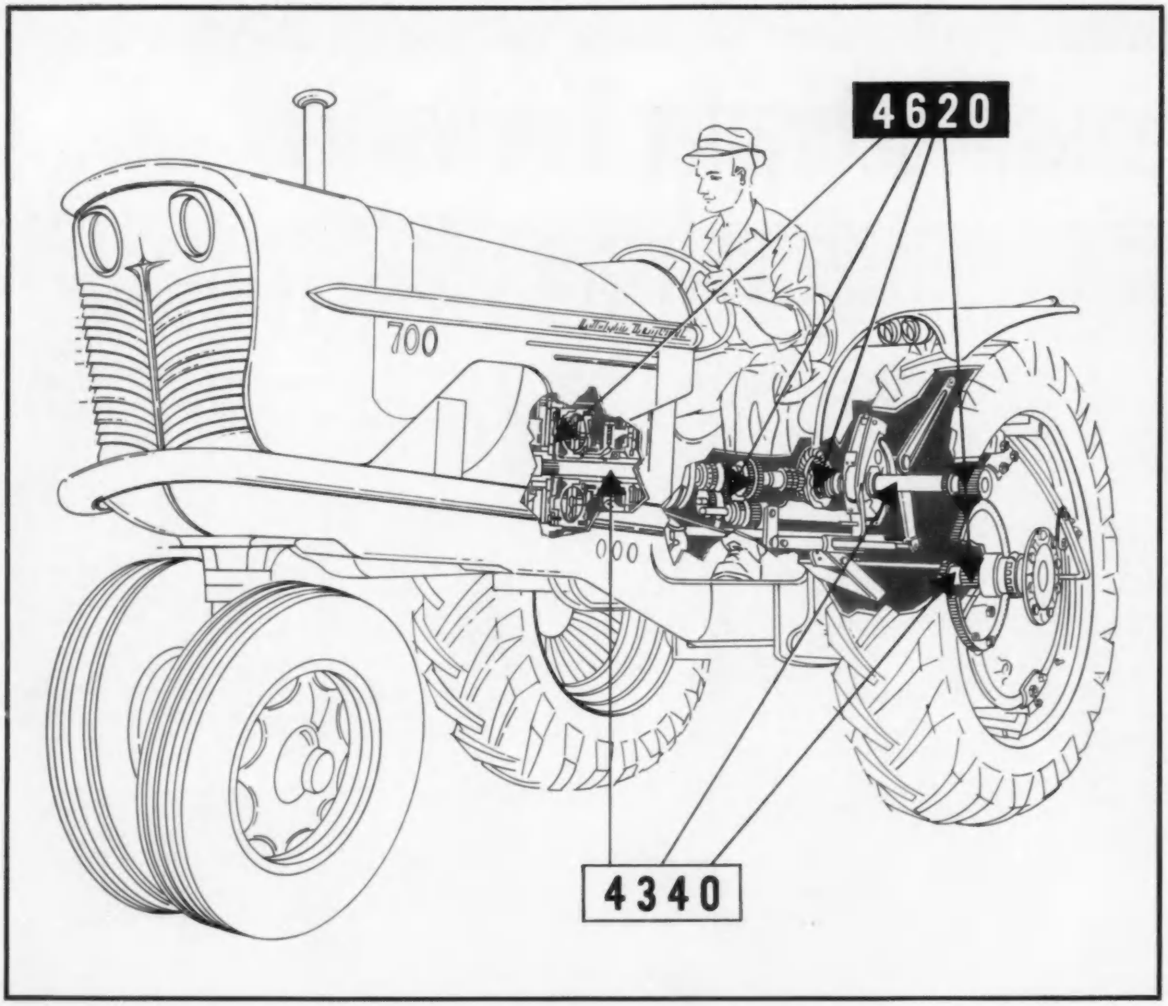

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And when you need a carburizing steel, simply specify 4620. It resists warpage and distortion in heat treatment. Responds reliably and uniformly, too. Provides a tough, strong core to support the hard, wear-resisting case.

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Super-strong trailer built 2,850 pounds

This 32-ton trailer is a progressive example of how to get maximum strength with least weight and low cost. The main frame members are a wide-flange beam design built up by welding USS "T-1" Steel plates together. "T-1" Steel, with a minimum yield strength of 100,000 psi, has enabled the Engineering Department of Martin Trailer Division of the Hyster Company to design to approximately two times their normal static stress and still maintain adequate factors of safety.

Eight-foot cross members are formed channel sections of USS MAN-TEN High Strength Steel, which has a minimum yield point of 45,000 psi in thicknesses of 3/4" and under. The combination of these two USS steels produced a weight saving of 2,850 pounds and represents a 21% decrease in dead weight of the unit.

Welding procedure. The "T-1" Constructional Alloy Steel beams are welded by submerged arc. The MAN-TEN Steel cross members are tack-welded to the main beams of "T-1" Steel, then finish welded by the shielded arc method.

"T-1" and MAN-TEN Steels pay off. The trailers are built by the Martin Trailer Division of the

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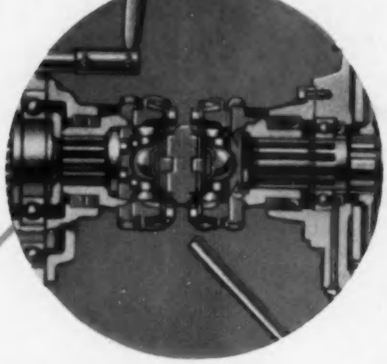
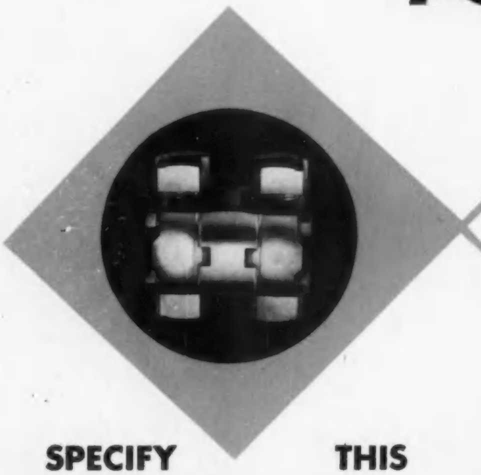


CLOSER COUPLING



SPECIFY THIS CLOSE-COUPLED "C"-TYPE

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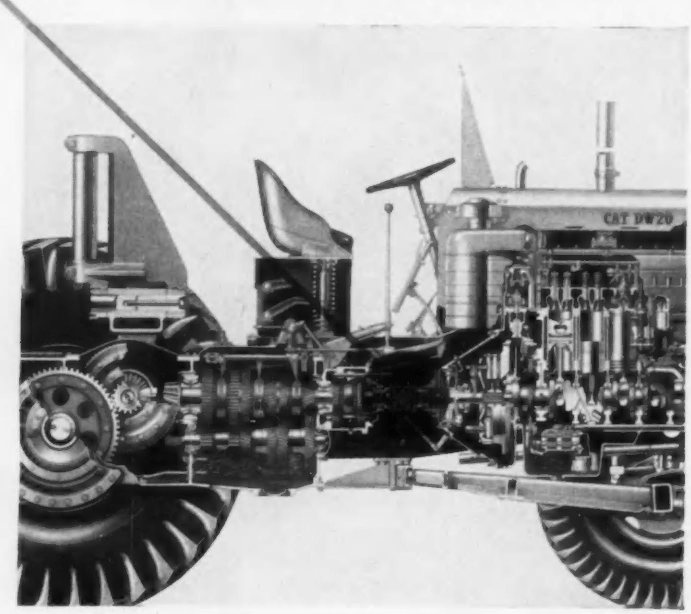
UNIVERSAL JOINT



If you are faced with the problem of locating a universal joint in a space where limited clearance does not permit the use of a flanged joint, MECHANICS close-coupled "C" Type Roller Bearing UNIVERSAL JOINT is your solution. This joint is specially designed for operation within cramped quarters that engineers formerly considered too short to accommodate a universal joint. Let our engineers show you how MECHANICS close-coupled UNIVERSAL JOINTS will conserve space, compensate for offset shafts and provide ample angularity in your new, compact models.

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375

Filter Papers Show Paranox 375 Superiority

Good Reference Fluid

Hours	Demerits
81	(0)
121	(0)
142	(0)
168	(0)
192	(0)
200	(7)

Samples filtered are from actual Powerglide tests with air injection.

Sludge on paper after filtering of fluid samples warns when oxidation resistance is lost.

Paranox 375 Fluid

Hours	Demerits
161	0
189	0
230	0
247	0
270	0
300	0

Tell-tale deposits begin at fluid "break point"

Shown here . . . Governors from two Powerglide transmissions . . . one on left with good reference oil . . . one on right with Paranox 375 formulation. Both oxidation tests made with air injection for 300 hours. The pictures tell the story.

	Viscosity (Centistokes) 100°F	210°F	V.I.
Base Oil A	18.7	3.71	89
Base Oil A+6.0 Vol.% Paranox 375	21.7	4.12	99
Base Oil B	16.4	3.37	77
Base Oil B+6.0 Vol.% Paranox 375	19.2	3.78	91

A Special VI boost... Another Paranox 375 Advantage

Paranox 375 has also shown the special quality of enhancing Viscosity Index of formulations, thus reducing VI improver treating costs. Shown here are two typical examples of what Paranox 375 does to improve VI of base oils.

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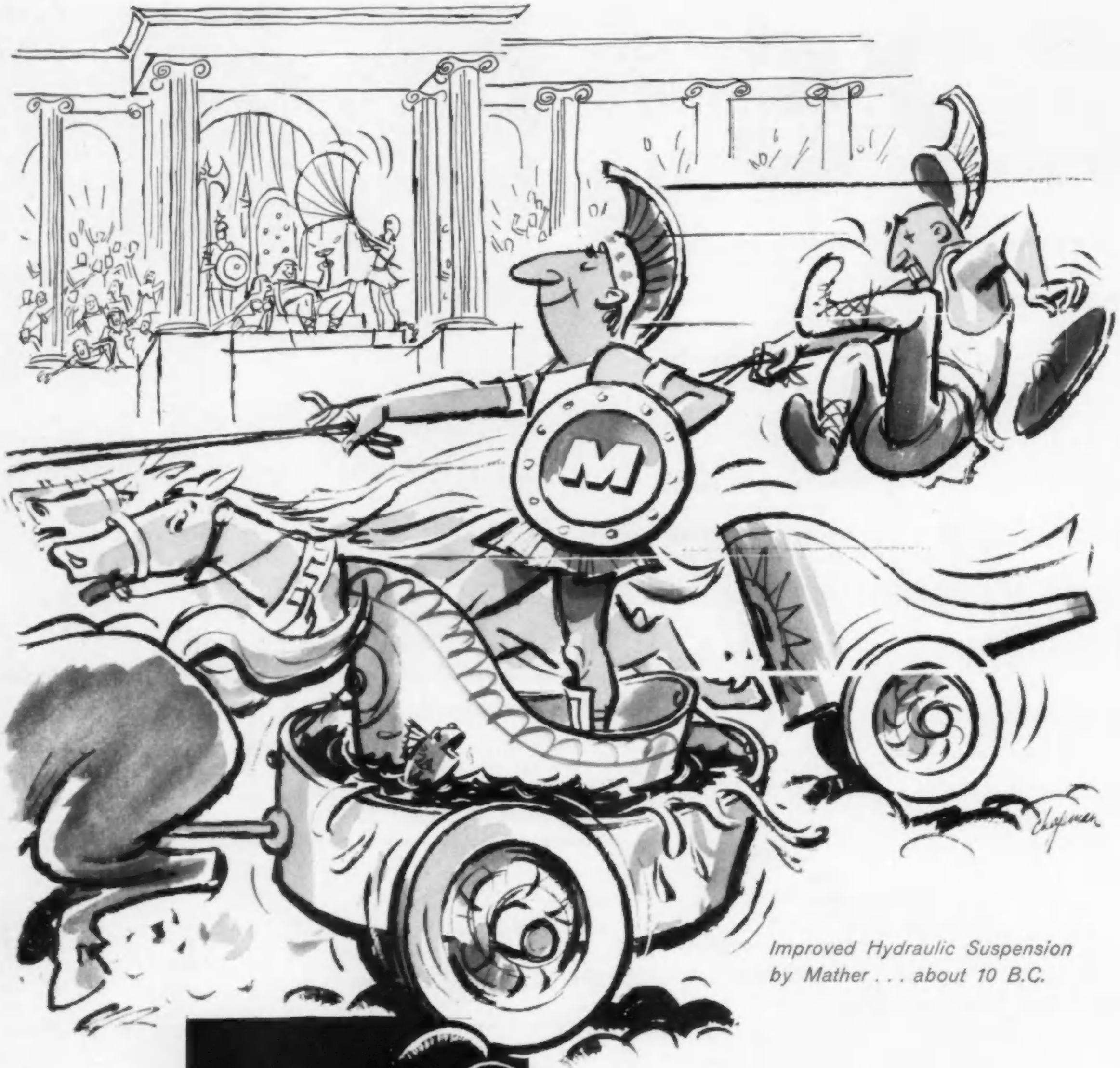

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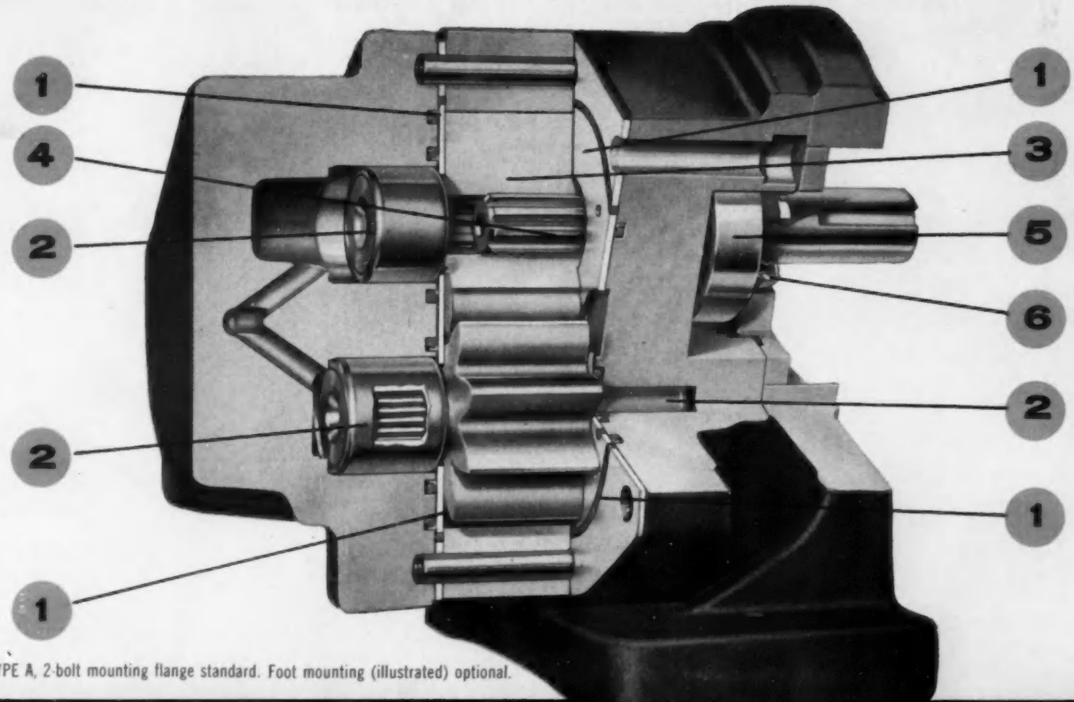

SAE TYPE A, 2-bolt mounting flange standard. Foot mounting (illustrated) optional.

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NEW WEBSTER "J" SERIES HYDRAULIC PUMP

HERE'S HOW WEBSTER PUTS NEW EFFICIENCY IN HYDRAULIC POWER . . . .

1 PRESSURE BALANCED WEAR PLATES — for high volumetric efficiency; prevents clearance changes due to heat.

4 FREE-FLOATING INTERNAL SPLINE DRIVES - no key failures.

2 NEEDLE BEARINGS — power-saving, anti-friction operation.

5 THRUST BEARING ON DRIVE SHAFT — absorbs compound driving thrusts.

3 ONE PIECE GEAR AND BEARING JOURNAL UNITS — assure minimum deflection and proper alignment on both drive and idler assembly.

6 DOUBLE LIP SEAL ON DRIVE SHAFT — gives added protection against seal failure and dirt.

Now — hydraulic power for your biggest mobile rig and the toughest jobs you can put it on. Webster's new "J" pump delivers 2000 psi — does it on less fuel and saves up to 4 horsepower in the bargain!

It's the result of a combination of pressure balanced wear plates and anti-friction bearings. Here's top efficiency from all-new Webster design that rates 10% or more above others in competitive ratings. Moreover, you get equally important advanced features (see sectional view) to assure dependable, trouble-free service.

Webster "J" series pump is trim, *very compact* — fits into tight quarters, mounts easily. It's available in 10 sizes from 5 to 40 gpm. Ask your Webster Electric representative for all the facts on this powerful new pump — or write direct for Bulletin HY1-1.

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Since it was formed in 1923, our Brake Engineering Department has established a unique record of development in its field. Four-wheel brakes, the duo-servo principle of braking, and automatic brake adjusters are just a few of the better-known brake advancements developed over the years. Most of the other automotive brakes built today are patterned after Bendix-type brakes.

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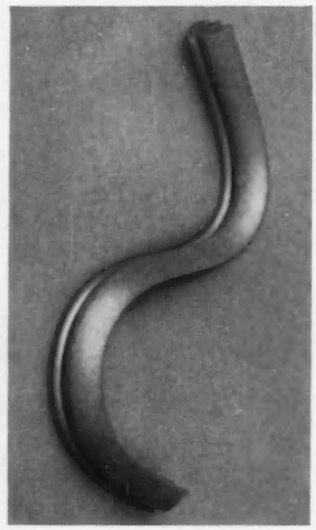

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R/M engineers helped marine transmission manufacturers solve clutch problems for this 55-ft. Chris-Craft Constellation. Twin engines develop up to 550 hp, provide speeds to 23 mph; equipped with newly designed hydraulic aluminum marine transmissions with R/M sintered bronze clutch material.

Photo courtesy Chris-Craft

How Raybestos-Manhattan helped design clutch for new marine transmission

"The extensive friction material knowledge and experience of R/M engineers save us time and money when we are working on a new design for a clutch or friction part," says Carl Benson, assistant manager and chief engineer, Paragon Gear Works, Taunton, Mass.

Solve problems on spot

"In developing our new 'H-A' hydraulic aluminum transmission, we took an R/M engineer right with us to our customer's engine plant in Michigan. We solved our clutch problems on the spot.

"Our customers appreciate this extra engineering service we can offer them through R/M. Wherever we are we know we can pick up the phone and have the nearest R/M engineer come to us. We get this extra service, yet prices are competitive; quality is uniformly high."

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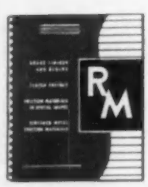
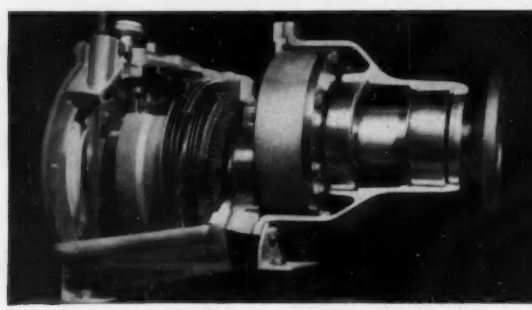


Send now for your free copy of Bulletin No. 501—packed with helpful engineering information on friction materials.



Advanced-design Paragon "H-A" hydraulic aluminum transmission for Chris-Craft 430 engine which develops 275 hp at 4000 rpm. Clutch is self-compensating; no adjustment ever.

Pencil points to R/M sintered metal clutch facing. .015 in. of sintered bronze on .070 in. steel plate. Has a high coefficient of friction in presence of oil; strength to withstand 4000 rpm; precision operation within narrow clearances of .007 to .010 in.

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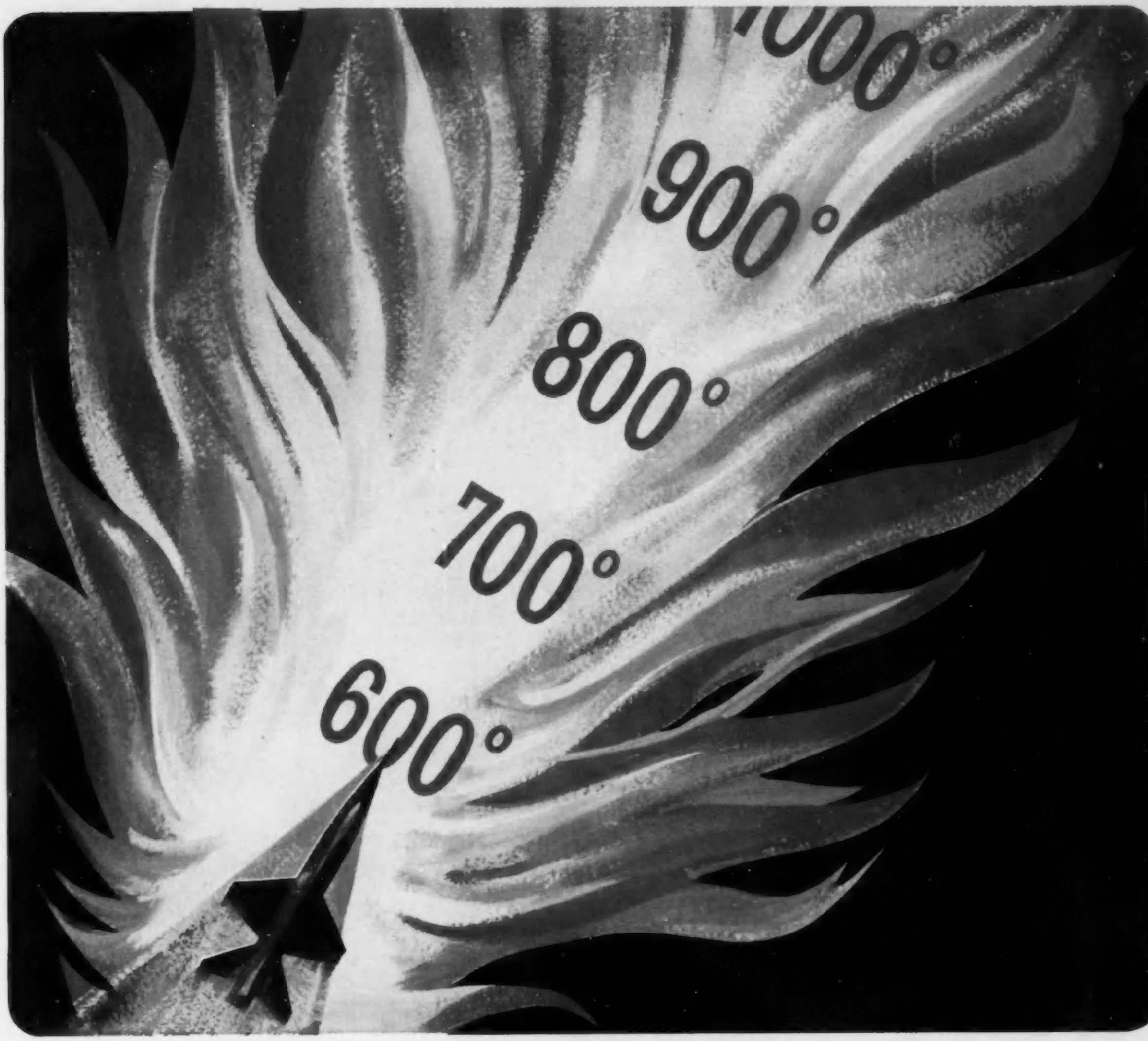

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For further information, see your A-L sales engineer or write for the new technical booklet, "AM 350 and AM 355." **Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa.**

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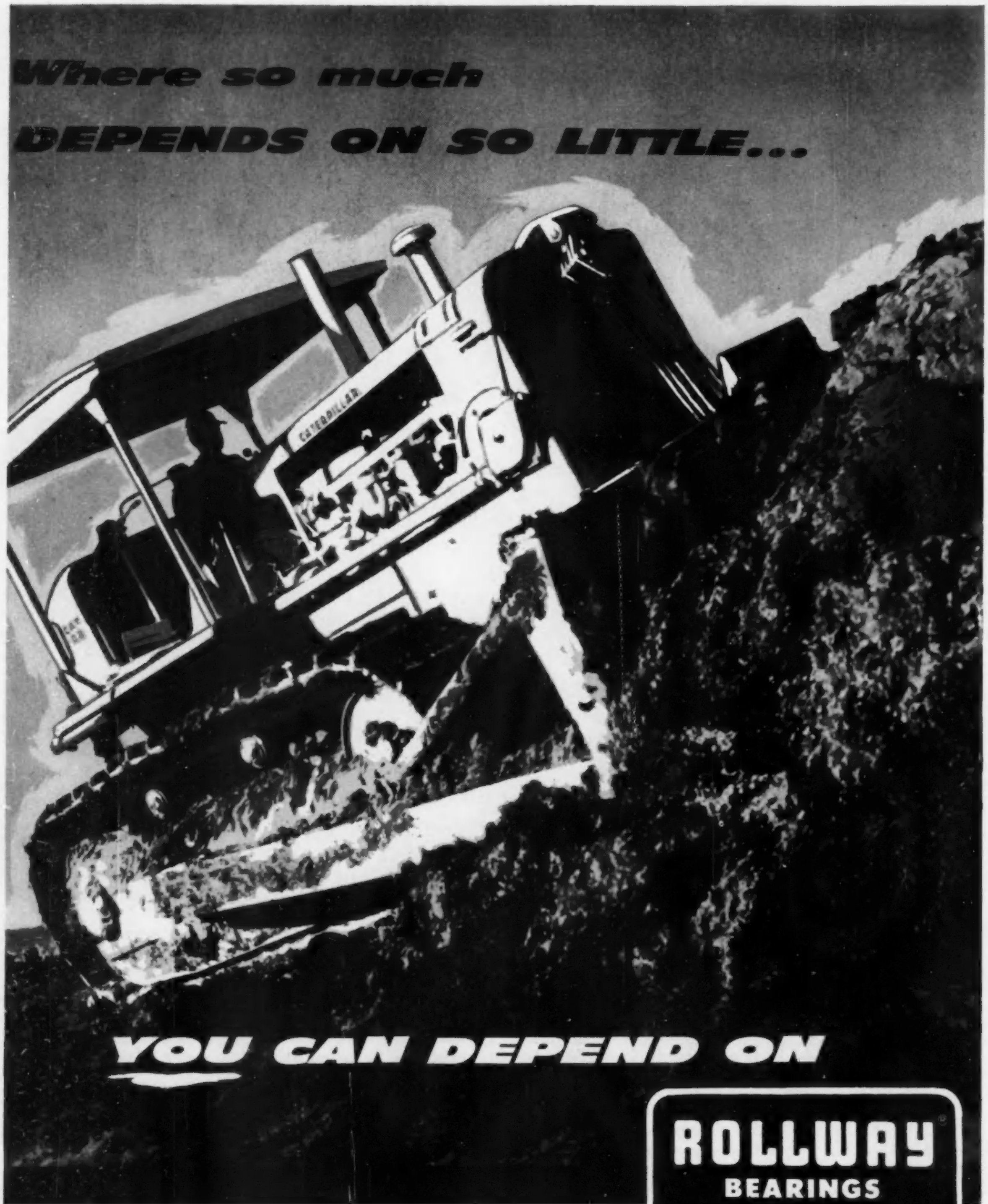

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THE SAGINAW b/b SCREW SAVED THE DAY WHEN...

A Garland Telescopic Crane Had to Lift an Atlas Missile!

"We were *really* up against it when we had to put up a 3-ton Atlas Missile for display at the World Congress of Flight in Las Vegas. Our telescopic crane was unable to "boom up" that much weight, with the high-friction threaded shaft we'd been using. Thanks to the competent assistance of your factory representative, and prompt delivery of the proper Saginaw Ball Bearing Screw, we licked the problem over a week-end. The Saginaw Screw's 90%-plus efficiency *actually tripled* our crane's boom-raising capability! It even brought us a *second* order from the Air Force. We're not only going to add Saginaw Screws to every new Garland crane, but install them in every one of the 1200 Garland cranes already in use!" says *Carl Frye, Sales Manager, Garland Crane Co., Long Beach, California.*

Perhaps the Saginaw b/b Screw can give *your* products that greater Sales Appeal you're looking for. Want details? Just write or phone Saginaw Steering Gear Division, General Motors Corporation, Saginaw, Michigan—*world's largest producers of b/b screws and splines.*

The Saginaw b/b Screw converts *rotary* motion into *linear* motion with over 90% efficiency. Saves power, space, weight, gives day-in, day-out dependability.

Boom used to raise Able into position for fastening onto Thor missile.

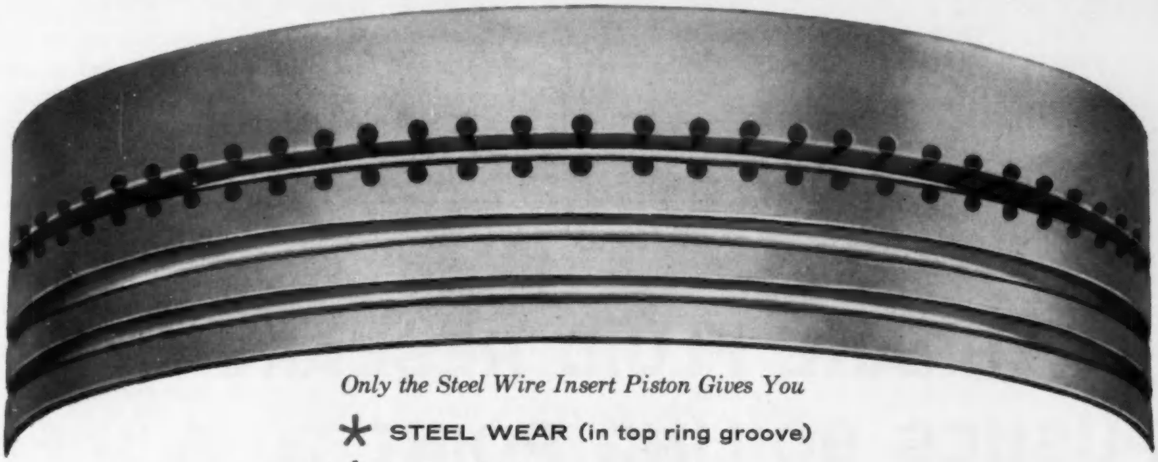
Actuation To Fit Your Individual Requirements

Have been built as small as 3/16 in. B.C.D. and 1½ in. long, as large as 6 in. B.C.D. and 40 ft. long. Larger sizes can be built to your order.

Saginaw ball bearing Screw

WORLD'S MOST EFFICIENT ACTUATION DEVICE

Got a tough
PISTON PROBLEM?



Only the Steel Wire Insert Piston Gives You

- ✱ STEEL WEAR (in top ring groove)
- ✱ ALUMINUM LIGHTNESS
- ✱ UNRESTRICTED HEAT FLOW

reduce the wear where the work is done... with
G & E WIRE INSERT PISTONS

Reducing top ring groove wear is the key to superior piston performance. G&E's patented wire reinforcing plus rapid, uniform heat flow keeps "tight as new" tolerances for remarkable mileages. Aluminum-light, steel-strong construction increases engine power and economy. G&E Wire Insert Pistons have a proven record for low cost per mile and trouble-free operation under the severest truck, tractor and construction uses. You'll save money, maintenance time, and break-down delays for your customers—by specifying the use of G&E Wire Insert Pistons.

Write for the G&E Steel Wire Insert Piston story today!

GILLETT AND EATON, INC.
853 Doughty St., Lake City, Minn.

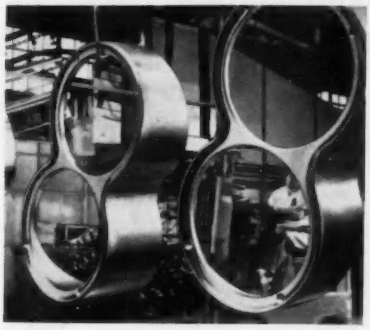
• A look at the coolant crystal ball . . .

In another area of Dow's Automotive Chemicals Laboratories, researchers are also taking the "years ahead" view. Their concern is not how to stop a car, but how to keep it running longer. These men are working on cooling systems and cooling system fluids for all types of engines—large and small, steel and aluminum. They're currently involved in several projects . . . improving corrosion inhibitors, for example . . . perfecting coolants that perform well under extreme conditions.

This continuing research has brought forth several cooling system advances in recent years. Dowgard*, the first year 'round coolant, is "Exhibit A". It replaces antifreeze, water and rust inhibitors in any automotive cooling system.

*TRADEMARK

Simulated radiators test new coolant formulations.



Prior to sub-assembly, parts get a bath in Dow solvents.

• Solvents scrub metal parts

Other Dow chemicals get into the car-making act long before cooling fluid is installed. The extensive group of Dow chlorinated solvents plays a key role in many manufacturing and subassembly operations. These solvents clean metal parts before plating, finishing or assembling, and they do it thoroughly and safely.

There are several of these Dow chlorinated solvents, each designed for specialized use. NEU-TRI® and ALK-TRI®, two grades of Dow trichloroethylene, are widely used in degreasing gears, tappets and other high precision parts. Dow perchloroethylene also serves in the vapor degreaser, particularly on white metal parts. Its high boiling point delivers faster, more thorough cleaning.

Chlorothene®, a safer versatile cold cleaning solvent, helps expedite production and maintenance cleaning of all types—spray, dip, or wipe. Although it is a powerful metal cleaner, Chlorothene is safe to use as a spot cleaner on upholstery.

• Non-skid test tracks

Seems it's increasingly important to automotive engineers that the test track be available for duty 365 days a year. Dow's calcium chloride helps keep the tracks open for business by melting ice in the winter and settling dust in the summer. It does the job quickly, yet its effect is long lasting. It is easy to handle in both the conventional flake form (Dowflake®) and the pellet form (Peladow®).

Calcium chloride helps keep test track ice-free, dust-free.

• Your inquiry welcomed

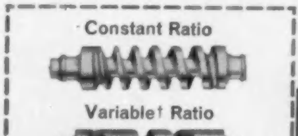
If you'd like to know more about any phase of Dow's activities in automotive chemistry, please write. Your inquiry will receive prompt attention by a member of our technical staff. Contact the Dow sales office near you or write to THE DOW CHEMICAL COMPANY, Midland, Michigan, Chemicals Merchandising Dept. 402EN3.

THE DOW CHEMICAL COMPANY
Midland, Michigan

DOW

See "The Dow Hour of Great Mysteries" on NBC-TV


Heavy-duty transport
Right
on the job...
VARIABLE-
RATIO
STEERING!
Farm machinery
Industrial equipment
Package delivery
Construction equipment


Constant Ratio
Variable† Ratio
†Originated and developed by Ross

All from 1 source...WAGNER

Complete straight air . . . air/hydraulic . . . hydraulic braking systems *FOR HEAVY-DUTY VEHICLES*

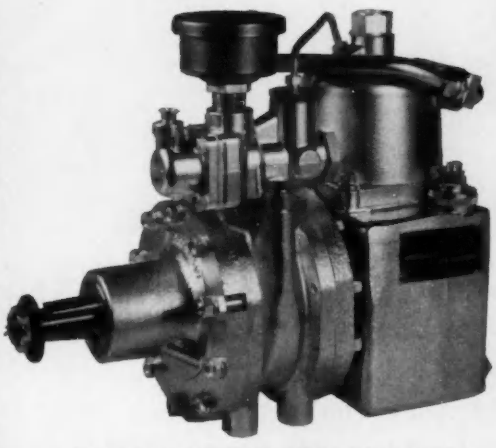
When you specify braking systems for heavy-duty vehicles, you can choose the system best suited to your needs, and get the complete system from Wagner. Only Wagner can supply components for all braking systems—everything from actuating systems to foundation brakes for straight air, hydraulic, or air-over-hydraulic brakes. The two new components and the time-proven rotary air compressor shown below point out the product development and the years of experience that have kept the name Wagner Lockheed first in braking for many years.

HEIGHT CONTROL VALVE

Used with vehicles equipped with air suspension to keep the floor height constant despite variations in loading. Efficient air usage sharply cuts compressor pumping time—lengthens compressor life.

AIR CAM BRAKE

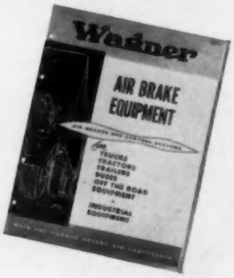
Designed for outstanding performance, this brake is completely interchangeable with Wagner Lockheed hydraulic foundation brakes. Standardization on Wagner brakes can simplify vehicle assembly lines—reduce inventories on axles—speed production.



ROTARY AIR COMPRESSOR. Proved by billions of miles of low maintenance service on thousands and thousands of vehicles. It provides all the advantages that only rotary compression can bring: rapid pressure recovery . . . cooler operation . . . smoother operation . . . quieter operation and longer operating life.

CONSULT YOUR WAGNER AIR BRAKE SPECIALIST

Let him help you with your specifications, and also ask him about the engineering consulting service available from Wagner.



Wagner Electric Corporation

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LOCKHEED BRAKE PARTS, FLUID, BRAKE LINING and LINED BRAKE SHOES • AIR HORNS • AIR BRAKES • TACHOGRAPHS • ELECTRIC MOTORS • TRANSFORMERS • INDUSTRIAL BRAKES

PLASTICS
in Design
Engineering

HOW TO SAVE TIME AND MONEY

Choose Garlock as *the* source for all your plastic needs. You'll benefit from Garlock's years of experience in injection molding, compression molding, extruding, punching, machining, and grinding of stock shapes and intricate parts. "Know-how" like this enables Garlock to recommend and furnish plastic materials *exactly* as you need them . . . without delay and at the lowest possible cost.

Garlock offers a wide selection of shapes and parts—regardless of size, tolerance, or quantity—in these engineered materials:

Teflon† TFE—contains the finest combination of chemical, electrical, and mechanical properties . . . chemically inert, outstanding electrical qualities, low coefficient of friction . . . withstands temperatures as low as −395°F, as high as +500°F.

Nylon—guaranteed bubble-free . . . has high tensile and compressive strength, good resistance to heat and chemicals, solvents, oils and greases, retains toughness at temperatures ranging from −40°F to +350°F.

Polychlorotrifluoroethylene (C.T.F.E.)—colorless, non-flammable . . . offers excellent dielectric properties, high compressive strength, resistance to chemicals, low cold flow in temperatures from −400°F to +390°F.

Teflon FEP—combines the exceptional properties of Teflon with the advantage of being easily melt-processed . . . **Delrin†**—offers metal-like strength and rigidity over a wide temperature range . . . **Polyethylene**—light, flexible, excellent electrical properties . . . **Polypropylene**—lightest of all known materials.

Garlock will work directly to your specifications or, upon request, will gladly assist you in product design and development.

For complete information contact one of Garlock's 26 sales offices and warehouses throughout the U.S. and Canada, or write for Plastics Catalog AD-171, The Garlock Packing Company, Palmyra, N. Y.

GARLOCK

Canadian Div.: The Garlock Packing Company of Canada Ltd.

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Order from the Garlock 2,000 . . . two thousand different styles of Packings, Gaskets, Seals, Molded & Extruded Rubber, Plastic Products

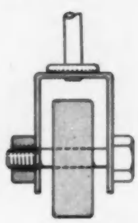
†DuPont Trademark

THE LIQUID LOCK FOR METAL PARTS
... improves fastener reliability and reduces costs!

LOCTITE sealant makes ordinary fasteners into lock fasteners at savings of 40%-70%. Locking action extends over the entire engaged area providing unequalled resistance to vibration ... ends breakdowns due to loosening of fasteners. A single drop of LOCTITE replaces all sizes of lock nuts, lock washers, lock screws, jam nuts, staking and interference threads.

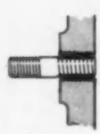
– ELIMINATES LOCK WASHER OR SELF-LOCKING SCREW

Makes ordinary screws into lock screws. Several times the holding power at savings of $20/M.



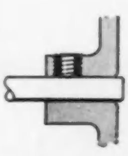
–ELIMINATES SELF-LOCKING NUT OR JAM NUT

Locks non-seated nuts anywhere along the length of thread.



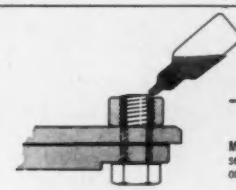
–ELIMINATES INTERFERENCE FIT

Locks studs securely ... locking action develops after stud is in place ... allows easy-driving Class 2 threads. End stripped threads, broken studs, damaged castings.



–ELIMINATES DOUBLE SET SCREWS, SELF-LOCKING SET SCREWS, JAM NUTS ON EXTENDED SET SCREWS OR STAKING

LOCTITE-treated set screws cannot vibrate loose ... end nuisance service calls.

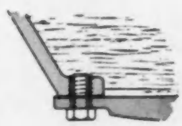


–ELIMINATES SELF-LOCKING NUT OR LOCK WASHER

Makes any nut a lock nut. Saves 40%-70%. Holds securely where lockwashers fail. Does not depend on tightening torque for locking action.

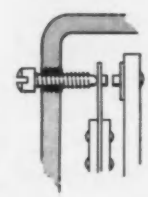
–ELIMINATES SPECIALS OR STAKING

Makes any threaded part self-locking.



–ELIMINATES BLIND HOLE TAPPING, SPECIAL LEAK-PROOF FASTENERS

LOCTITE locks and seals threaded parts against vibration and high-pressure fluids.



–ELIMINATES SELF-LOCKING SCREW OR JAM NUT

Get the right setting the first try ... no backlash. LOCTITE provides the proper amount of drag to hold adjustment securely. Permits repeated adjustments.

LOCTITE Sealant is easy to apply ... simple to automate

Labor savings are obtained when several days supply of threaded parts are treated by tumbling with LOCTITE Sealant. Treated parts store for days, lock only when assembled. Smaller quantities may be tumbled by hand in polyethylene bags. Parts may be individually treated using applicator nozzle on LOCTITE bottle or by using continuous feed tube. Parts may be treated *after* assembly, LOCTITE wicks into threads by capillary action.

LOCTITE is a thin liquid that hardens into a tough heat and oil-resistant seal when confined between closely fitting metal parts. It requires no heating or mixing ... does not air dry. LOCTITE comes fully prepared ... stores for years ... hardens only when treated parts are assembled. Ten grades provide any desired torque to all sizes and types of fasteners. LOCTITE-treated fasteners may be removed with ordinary tools ... fasteners may be re-used.

LOCTITE Kit No. 10-10

Contains 10 grades of Loctite sealant specially put up to assist engineers in determining proper grade of Loctite in product development and for general experimental work. By selection of proper grade, the designer can apply a pre-determined amount of locking torque.

Write for literature and free sample capsule.

LOCTITE® SEALANT

AMERICAN SEALANTS COMPANY • 255 WOODBINE ST., HARTFORD 6, CONN.

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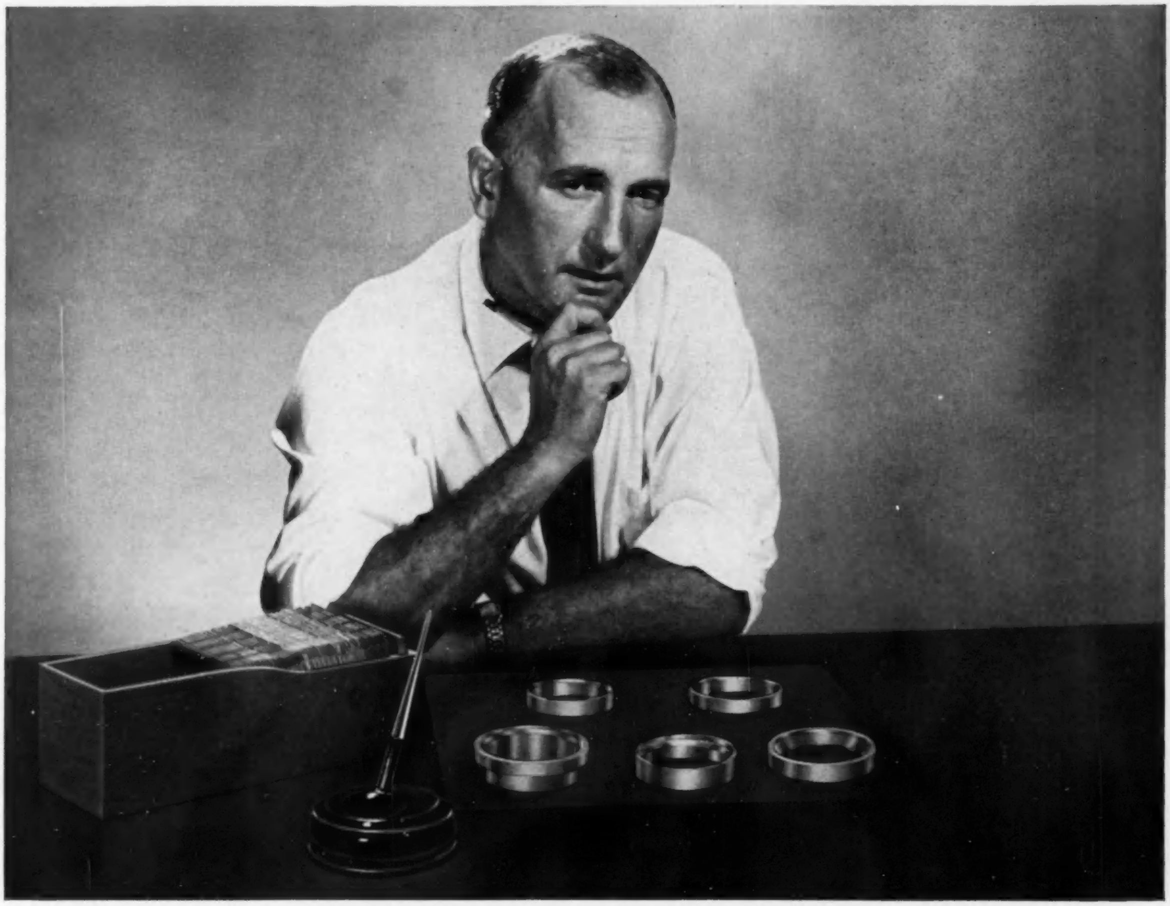

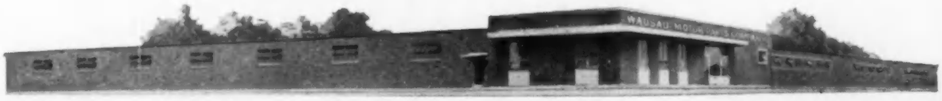

METROPOLITAN MUSEUM OF ART

Why Henri de Valois was fearless in the jousts

Few men at the Royal Court could hold their own against the man who became the King of France in 1547. One writer of the day said, "One might believe him all made of muscle". Henri could afford to be fearless; his armor was a product of the most skilled craftsmen, as you can see from the helmet above, thought to have been his.

People might think the art of working metal so skillfully is lost today. It isn't. Actually, the expert armorer might have learned a thing or two about fine metalworking in a Timken® roller bearing plant. Surface smoothness in millionths of an inch. The finest bearing-quality alloy steel available. And we know steel. We've been making fine alloy steel for over forty years.

That's why Timken tapered roller bearings deliver the kind of trouble-free performance that keeps your customers happy, the kind of bearing performance that cuts warranty and assembly costs in cars, trucks and busses.

Your engineers know about this extra quality which costs you nothing extra. At Bucyrus, Ohio, we're producing "Green Light" bearings—leading the way in high uniform quality, low bearing costs. For quality and service you can't get anywhere else, specify "Timken" instead of just a part number. The Timken Roller Bearing Company, Canton 6, Ohio. Cable address: "TIMROSCO". Makers of Tapered Roller Bearings, Fine Alloy Steel and Removable Rock Bits.

Timken "Green Light" bearings mean:

- **Lower prices**
- **Lower warranty costs**
- **Lower costs of assembly**

BETTER-NESS rolls on

TIMKEN®

tapered roller bearings